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INSTRUCTION MANUAL

MODEL 1905
DISPLAY
OSCILLOSCOPE

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WAVETEK® INDIANA, INC.
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BEECH GROVE, INDIANA 46107
317-787-3332
(TOLL FREE OUTSIDE INDIANA)
1-800-428-4424

Serial No. _____

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CONTENTS

SECTION 1 – GENERAL INFORMATION
- 1.1 INTRODUCTION
- 1.2 SPECIFICATIONS

SECTION 2 – OPERATION
- 2.1 INTRODUCTION
- 2.2 INSTALLATION
- 2.3 DESCRIPTION OF FRONT PANEL
- 2.4 DESCRIPTION OF REAR PANEL
- 2.5 INTERNAL CONTROLS

SECTION 3 – CIRCUIT DESCRIPTION
- 3.1 INTRODUCTION
- 3.2 BLOCK DIAGRAM ANALYSIS
- 3.3 POWER SUPPLY
- 3.4 HIGH VOLTAGE SUPPLY
- 3.5 VERTICAL PREAMPLIFIER
- 3.6 VERTICAL AMPLIFIER
- 3.7 HORIZONTAL AMPLIFIER
- 3.8 AUTO BLANKING CIRCUIT
- 3.9 Z-AXIS AMPLIFIER
- 3.10 CATHODE RAY TUBE

SECTION 4 – MAINTENANCE
- 4.1 INTRODUCTION
- 4.2 DISASSEMBLY
- 4.3 REASSEMBLY
- 4.4 PERFORMANCE TESTS AND CALIBRATION
- 4.5 TROUBLESHOOTING

SECTION 5 – REPLACEABLE PARTS
- 5.1 INTRODUCTION
- 5.2 MANUFACTURERS CODE
- *** PARTS LISTS

SECTION 6 – SCHEMATICS
- 6.1 INTRODUCTION
- 6.2 SCHEMATIC NOTES
- *** SCHEMATICS

CHANGE INFORMATION, IF ANY, IS LOCATED AT THE REAR OF THIS MANUAL.

SECTION 1
GENERAL INFORMATION

1.1 INTRODUCTION

The Wavetek Display Oscilloscope is a versatile, low-cost, compact, solid-state, 9 inch X-Y Display Oscilloscope designed for general purpose applications. Standard features include:

Excellent full-scan linearity.

User inputs and controls mounted on the instrument front and rear panels. These include horizontal, vertical, and Z-axis inputs; and vertical, horizontal, and Z-axis gain; vertical and horizontal position; and intensity controls.

Intensity modulation circuit with contrast control independent of the rear-panel intensity control (polarity internally reversible).

Spot blanking circuit to prevent CRT phosphor burning.

Internally reversible vertical and horizontal deflection polarities.

Selectable (115/230 VAC) primary voltage.

The Display Oscilloscope also has outstanding mechanical strength and electrical reliability.

The Display Oscilloscope is designed primarily for use with low sweep rate (<200 Hz) sweep generators. For other applications, consult the factory.

1.2 SPECIFICATIONS

1.2.1 DISPLAY

CRT	23 cm (9 in.) diagonal; P-1 phosphor (other phosphors available on request)
DEFLECTION	Magnetic
ACCELERATION VOLTAGE	8 kV nominal
GRATICULE	1.2 cm/div, 10 vertical x 14 horizontal

1.2.2 VERTICAL

SENSITIVITY	4-position step attenuator for 1, 10, 100 mV and 1 V/div; continuously adjustable vernier between steps.
INPUT IMPEDANCE	374 kohm
BANDWIDTH	DC to >15 kHz (3 dB point) for 9 div deflection.
COUPLING	DC (AC coupling via rear-panel switch)
LINEARITY	3%
DRIFT	<0.5 div/8 hr (at constant ambient temperature after ½ hour warm-up).
POLARITY	Positive voltage deflects trace upward; reversible via rear-panel switch.
POSITION	Continuously adjustable over 2 times full screen.

1.2.3 HORIZONTAL

SENSITIVITY	Continuously adjustable from <0.1 V/div to >10 V/div.
INPUT IMPEDANCE	>320 kohm
BANDWIDTH	DC to >1.5 kHz (3 dB point) for 13 div deflection.
LINEARITY	3%
COUPLING	DC (AC coupling via rear-panel switch)
DRIFT	<0.5 div/8 hr (at constant ambient temperature after ½ hour warm-up).
POLARITY	Positive voltage deflects trace to the right (internally reversible).
POSITION	Continuously adjustable over 2 times full screen.

1.2.4 INTENSITY MODULATION

SENSITIVITY	Adjustable via rear-panel CONTRAST control from 1 to 10 Vpp for full modulation.
POLARITY	Positive signal brightens trace (internally reversible).
INPUT IMPEDANCE	20 kohm nominal
BANDWIDTH	DC to 3.5 MHz (3 dB point); DC to 10.0 MHz (10 dB point).

1.2.5 PROTECTION CIRCUIT

Auto blanking protects the phosphor in the event of loss of deflection signal. Either horizontal or vertical signals of approximately 6 div (<60 Hz) will cause "unblanking".

1.2.6 GENERAL

DIMENSIONS	28.6 cm (11 1/4 in) wide 24.1 cm (9 1/2 in) high 29.5 cm (11 5/8 in) deep
WEIGHT	8.4 kg (18 1/2 lb)
POWER	115/230 VAC ± 10%; 50/60 Hz; approximately 75 watts

SECTION 2
OPERATION

2.1 INTRODUCTION

This section covers mechanical installation, description of front- and rear-panel and internal controls, line voltage conversion, and operating instructions.

2.2 INSTALLATION

2.2.1 INITIAL INSPECTION

After unpacking, the instrument should be inspected for physical damage. The electrical performance checks are contained in Section 4. The shipping container and the packing material should be saved in case it becomes necessary to reship the unit.

If there is physical damage or the unit does not meet the electrical performance checks, notify the nearest Wavetek area representative or the factory in Indiana. If the shipping container shows damage, notify the carrier. Retain the shipping container and packing material for the carrier's inspection. In either case, the factory or area representative will arrange for immediate repair or replacement of your instrument, without waiting for damage claim settlements.

2.3 DESCRIPTION OF FRONT PANEL

Refer to Figure 2-1.

POWER switch applies primary power to the instrument. The LED pilot light indicates operation.

INTENSITY control adjusts the intensity or brightness of the display.

HORIZONTAL POSITION control adjusts the horizontal positioning of the display.

HORIZONTAL GAIN control provides a continuously variable adjustment of the horizontal input signal.

VERTICAL POSITION control adjusts the vertical positioning of the display.

VERTICAL GAIN control provides continuously variable adjustment of the vertical input signal between V/DIV control steps.

V/DIV control selects vertical input sensitivity in four decade steps.

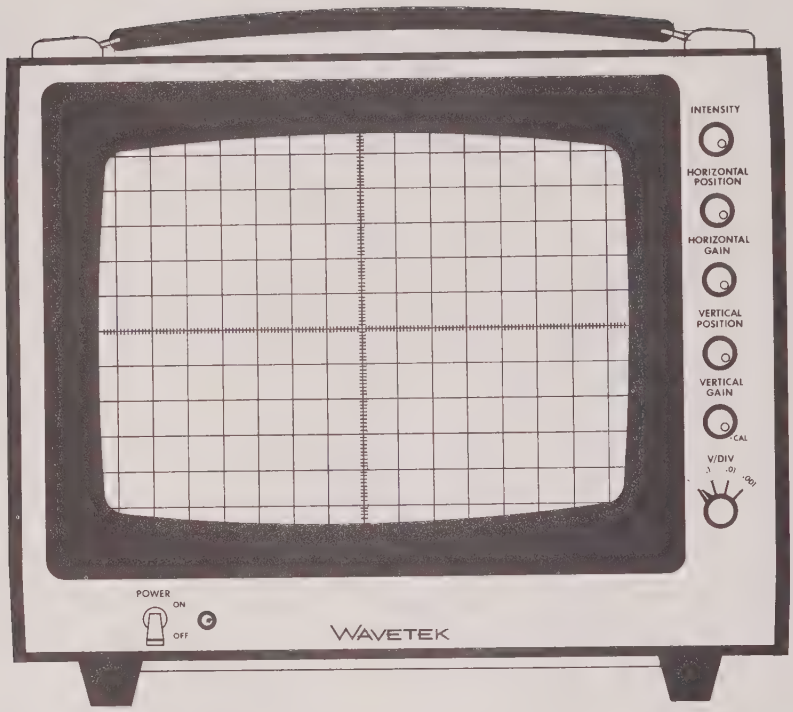


Figure 2-1. Front Panel

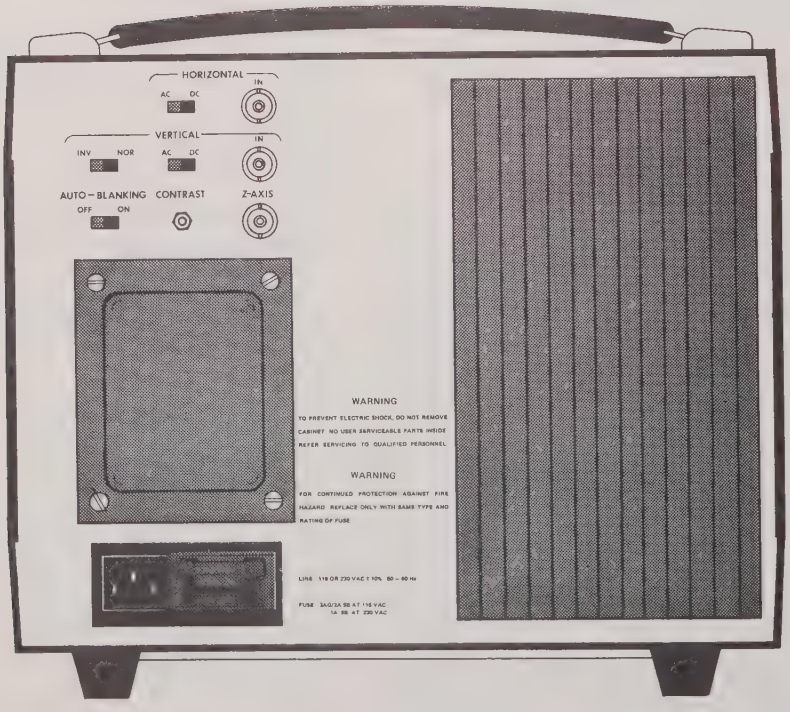


Figure 2-2. Rear Panel

2.4 DESCRIPTION OF REAR PANEL

Refer to Figure 2-2.

HORIZONTAL INPUT connector (BNC) provides connection for horizontal signal.

HORIZONTAL AC/DC switch selects mode of horizontal input coupling.

VERTICAL INPUT connector (BNC) provides connection for vertical signal.

VERTICAL AC/DC switch selects mode of vertical input coupling.

VERTICAL INVERT switch—Normal positive signal deflects trace upward; inverted positive signal deflects trace downward.

Z-AXIS INPUT connector (BNC) provides input for intensity modulation of trace.

CONTRAST control attenuates the Z-axis input signal for desired amount of intensity modulation.

AUTO BLANKING DEFEAT overrides the auto blanking circuit for the purpose of using very low frequency deflection signals.

CAUTION

When operating with auto blanking defeated, use reduced intensity to minimize the risk of burning the CRT phosphor.

AC LINE connector enables unit to operate from 115 or 230 VAC supply mains, and provides connector to AC mains via line cord with 3-prong plug. The connector includes the AC LINE fuse (time-delay); 2 amp for 115 VAC operation; 1 amp for 230 VAC operation.

2.5 INTERNAL CONTROLS

Refer to Figure 2-3.

The Focus control, located on the High Voltage Board (accessible through the rearward hole in the V/H Amplifier Board), adjusts the sharpness of the display.

The High Voltage Adjustment, located on the High Voltage Board (accessible through the forward hole in the V/H Amplifier Board), calibrates the High Voltage supply.

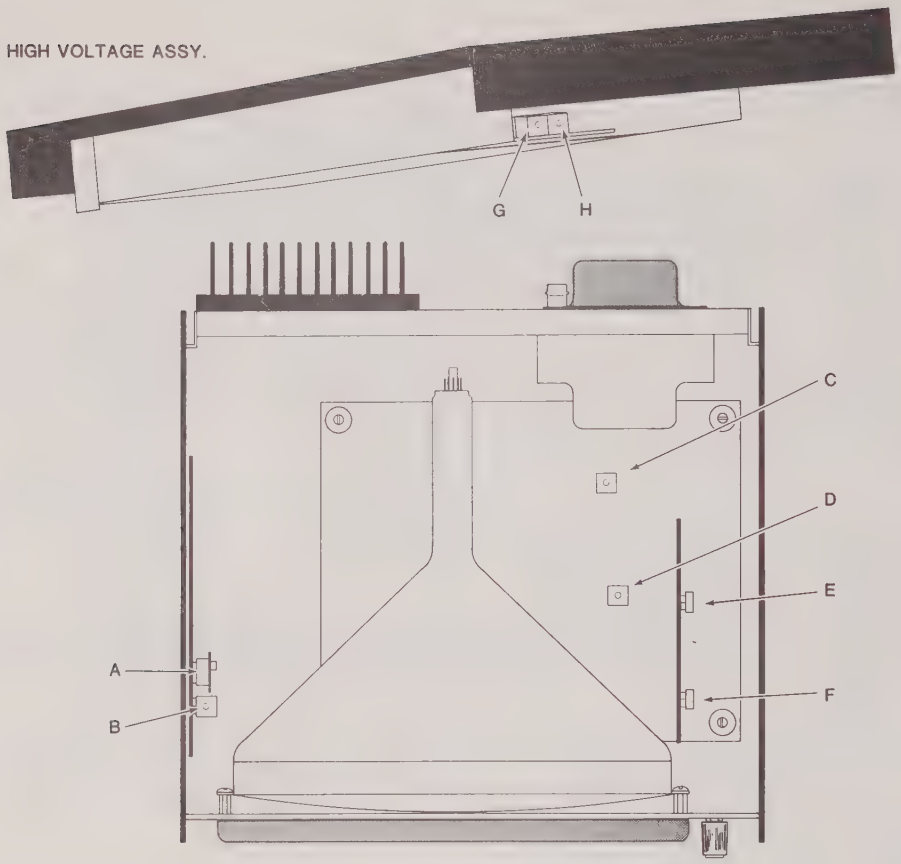
The Horizontal (bottom) and Vertical (top) linearity controls, located on the V/H Amplifier Board, calibrate the linearity of the display.

The Intensity Limit control, located on the PS/Z-axis Blanking Board, sets the maximum brightness level adjustable via the rear-panel INTENSITY control.

The Z-Axis Polarity switch, located on the PS/Z-axis Blanking Board, reverses the polarity of the Z-AXIS INPUT signal.

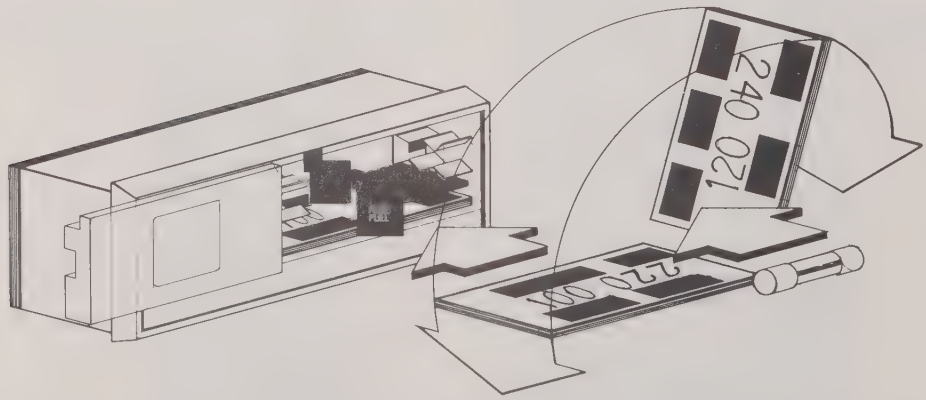
The Vertical Cal control, located on the Preamp Assembly, calibrates the vertical gain (maximum setting of the front-panel control).

The Vertical Balance control eliminates offset in the Vertical Amplifier. It is adjusted for minimum deflection of the trace when the VERTICAL GAIN control is fully ccw (no signal input).



A Z-AXIS POLARITY
B INTENSITY LIMIT
C HORIZONTAL LINEARITY
D VERTICAL LINEARITY
E VERTICAL GAIN
F BALANCE
G HIGH VOLTAGE
H FOCUS

Figure 2-3. Internal Controls



Remove the line cord and slide the window all the way to the left. Remove the fuse by pulling the lever. Remove the voltage-selector card. Orient the voltage-selector card so that the desired voltage is in the upper left and push the card firmly into the slot. Swing the lever to the right and check that the selected voltage is visible. Replace the fuse, slide the window to the right, and replace the line cord.
NOTE: Check that the fuse is the proper value for the selected voltage.

Figure 2-4. Voltage Selection

SECTION 3
CIRCUIT DESCRIPTION

3.1 INTRODUCTION

This section first presents an overall block diagram analysis followed by a more detailed description of each block.

3.2 BLOCK DIAGRAM ANALYSIS

The block diagram of Figure 3-1 shows the relationship of each main section to the total operation of the instrument. The CRT (cathode ray tube) is the heart of the display. The composite signal of all inputs to the instrument is displayed on the face of the CRT.

The Power Supply and its associated regulators provide the instrument with five voltage sources. The ±30 volt supplies are unregulated. The ±15 volt supplies are IC regulated, and the +68 volt supply is Zener stabilized.

The High Voltage supply provides +8 kV to the anode of the CRT. The power source for this section is the +30 volt supply. The High Voltage supply also provides +100 V for G2 and 0 to +165 V for G4 (the focusing electrode) of the CRT.

The Vertical Preamplifier and Amplifier convert the input voltage into a current signal for the vertical deflection yoke. The Vertical Preamplifier controls the gain of the vertical display, while the Vertical Amplifier controls the position of the vertical display on the CRT.

The Horizontal Amplifier converts the input voltage signal to a corresponding current signal for the horizontal deflection yoke. The Horizontal Amplifier has controls for adjusting the gain and position of the horizontal display on the CRT.

The CRT cathode is biased by the Z-Axis Amplifier. This amplifier includes the CONTRAST control which adjusts the amplitude of the intensity modulation signal, and the display INTENSITY control.

The Auto Blanking circuit turns off the electron beam when both the horizontal and vertical signals are too small or too slow, thus preventing damage to the CRT phosphor.

3.3 POWER SUPPLY

The power transformer is located on the rear panel while the rectifier diodes, regulators, and filter capacitors are located on the Power Supply/Z-Axis Blanking Board. The outputs are ±30 V unregulated DC, and ±15 V and +68 V regulated DC.

A dual-primary transformer, T201, allows for a line voltage of either 115 or 230 VAC. The 48 V secondary is center tapped to allow for two full-wave rectified voltages. Unregulated ±30 V are filtered by C118/C119 and C116/C117 respectively. The ±15 V supplies are IC regulators powered by the ±30 V supply. The +68 V supply is Zener diode regulated.

3.4 HIGH VOLTAGE SUPPLY

The High Voltage circuit is located away from the main printed-circuit board, and housed in a shielded enclosure to prevent 20 kHz radiation. The high voltage circuit contains transistors Q301, Q302, and Q303. It provides 8 kV to the CRT anode, as well as the voltage for the focusing electrode

(G4) and +100 V for G2. Q303 is the heart of a ringing choke oscillator that develops a 20 kHz signal across T301. The oscillator signal is stepped up from 14 Vp to 2 kVp in the secondary of the transformer. It is then increased to +8 kV DC by the cascade quadrupler. The oscillator signal is stepped up to 310 Vp in the other secondary and rectified by CR303. The 310 volts is then fed to the Focus control, R305. The 100 volt supply is derived from a voltage divider on the 310 volt output.

Q301 and Q302 provide the supply voltage to the oscillator. This voltage is varied by a feedback signal in order to maintain a constant output level from the oscillator. The feedback is taken from R303, which is also the High Voltage adjustment. As the 8 kV supply is loaded, a bigger load is seen by the oscillator. This temporarily lowers the oscillator supply voltage, consequently coupling less voltage to the 310 V circuit. This results in a lower voltage at R303. This lower voltage is inverted and amplified to provide a larger voltage supply to the oscillator, thus correcting for the additional loading.

3.5 VERTICAL PREAMPLIFIER

The Vertical Preamplifier consists of IC601, IC602A, and IC602B. The V/DIV switch in the feedback circuit of IC601 selects the proper amount of attenuation or gain for the stage. The VERTICAL GAIN control feeds the signal to IC602A, a non-inverting voltage gain stage. The output of this stage is fed to IC602B with inverting or non-inverting gain of one (depending on the setting of the rear-panel INVERT switch, S5).

3.6 VERTICAL AMPLIFIER

The Vertical Amplifier consists of IC201, Q201 through Q206, Q1, and Q2. The input signal is connected directly across VERTICAL GAIN control R1, which feeds a selected portion of the input signal to IC201A. This operational amplifier acts as a buffer for the vertical input signal. The output is then routed to an inverting operational amplifer, IC201B. The other inputs to IC201B are the vertical position bias and the feedback voltage from R164/R219, which is proportional to the current signal through vertical yoke L1A. The circuit consisting of R223, R224, R232, CR203, CR204, CR205, CR206 improves display linearity during the furthest excursion of the signal.

The output of IC201B drives a complementary symmetry push-pull amplifier consisting of Q202, Q203, Q204, Q205, Q1 and Q2. This provides the high current gain necessary for driving vertical yoke L1A. Q201 and Q206 provide current limiting for Q1 and Q2 to prevent damage to the power transistors when the incoming signal is sufficient to deflect the display off the CRT face.

Vertical yoke L1A provides the magnetic field for vertical deflection of the electron beam.

3.7 HORIZONTAL AMPLIFIER

The Horizontal Amplifier consists of IC202, Q207 through Q210, Q3, and Q4. The horizontal input signal is fed directly to HORIZONTAL GAIN control R3, which feeds a selected portion of the input signal to IC202A which acts as a buffer for the horizontal input signal. The output is then fed to IC202B along with the horizontal position bias and the feedback voltage from R250. The circuitry consisting of R253, R254, R255, CR215, CR216, CR217, and CR218 improves display linearity during the furthest excursion of the signal.

The output of IC202B drives a complementary symmetry push-pull amplifier consisting of Q208, Q209, Q3, and Q4. This amplifier provides the high current gain necessary for driving horizontal yoke L1B. Q207 and Q210 are current limiters which prevent damage to Q3 and Q4 when the incoming signal is sufficient to deflect the display off the CRT face.

Horizontal yoke L1B provides the magnetic field for horizontal deflection of the electron beam.

3.8 AUTO BLANKING CIRCUIT

This circuit consists of IC101A and IC101B. The input to IC101B is a sample from the Horizontal Amplifier while the input to IC101A is a sample from the Vertical Amplifier. These AC signals are amplified and an average negative value is detected by CR105, CR106, and C103. Q101 is biased on by the detected signal. When the deflection is less than approximately 3 cm (60 Hz rate), the detected voltage on C103 is not sufficient to keep Q101 turned on. Turning Q101 off allows "G1" of the CRT to be biased with the −30 volt supply through R116. This voltage will prevent electron flow to the CRT face, thus preventing damage to the phosphor when both signals are missing or very small.

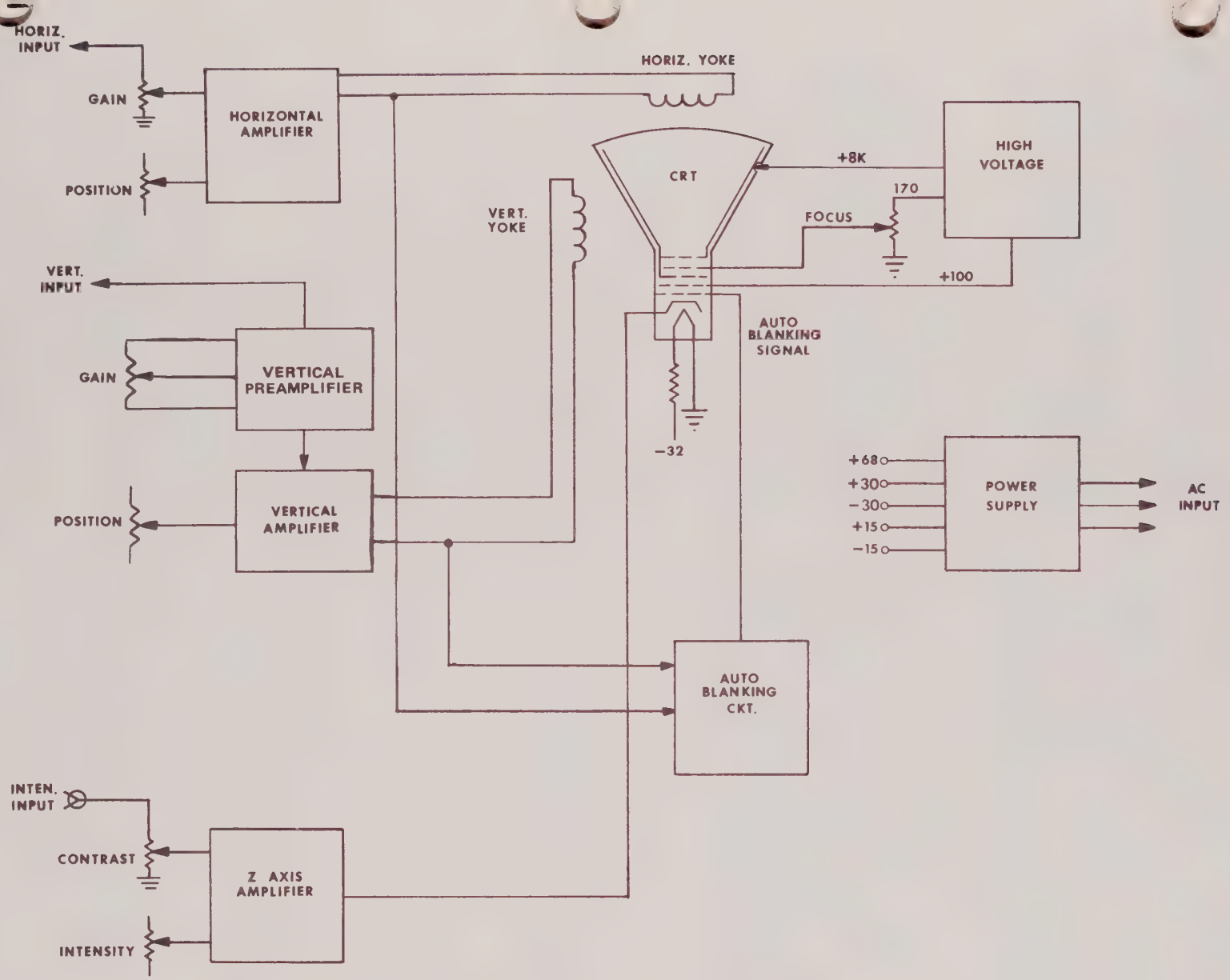


Figure 3-1. Simplified Block Diagram

3.9 Z-AXIS AMPLIFIER

3.9.1 INTENSITY CONTROL

The display intensity is controlled by changing the CRT cathode bias voltage. Decreasing the positive voltage on the cathode increases the brightness level, while increasing the voltage decreases the brightness level. The cathode bias point is adjusted by Q105, Q106, and Q107, as determined by the settings of Intensity Limit control R114 and INTENSITY control R5.

3.9.2 INTENSITY MODULATION

The intensity Modulation Amplifier consists of Q102, Q103, and Q104. The input signal is connected directly to CONTRAST control R5, which applies a selected portion of the signal to high-impedance buffer Q102. Q102 varies the bias applied to emitter follower Q104. Q103 is used in a temperature-compensation network to reduce variations in Q104's bias caused by temperature changes. Q104 then drives common-base (or common emitter, depending upon the setting of S101) transistor Q105 to vary the CRT cathode bias point.

When Q105 is used in common-base configuration, a positive intensity-modulation signal will cause the trace to brighten (negative blanking), while a common-emitter connection for Q105 will result in positive blanking.

3.10 CATHODE RAY TUBE

The CRT is a 9 inch (diagonal measure) rectangular tube using magnetic deflection, and has the following specifications: P1 phosphor standard (other phosphors optional); electrostatic focusing (G4); 90ðiagonal deflection; 12.6 V heater voltage.

The screen is supplied with +8 kV by the High Voltage circuit.

SECTION 4
MAINTENANCE

4.1 INTRODUCTION

This section provides information for testing, calibrating, and troubleshooting the Display Oscilloscope.

4.2 DISASSEMBLY

Should it become necessary to remove one or more of the internal assemblies for servicing, the following procedures should be followed.

4.2.1 COVER REMOVAL

Turn the instrument upside down and remove the four 8-32 x 2¼ screws from the bottom cover. Turn the instrument right side up. Carefully lift the top cover enough to clear the side cover extenders. Lift the cover extenders from the instrument. Discharge the CRT second anode and disconnect the CRT second anode lead and the High Voltage supply harness connectors.

NOTE

Discharge the CRT second anode to the CRT tension band, not to one of the PC board grounds.

Pull the right-side bracket outward enough to clear the front-panel-mounted controls and carefully lift the top cover from the instrument.

4.2.2 POWER SUPPLY/Z-AXIS BOARD

Remove the harness connectors and the two screws securing the PC assembly to the bottom cover. Lift the PC assembly from the instrument.

4.2.3 FRONT PANEL/CRT ASSEMBLY

Disconnect the Vertical Preamp Board harness, the CRT connector, and the yoke connector. Slide the Front Panel/CRT assembly out of the slot in the bottom cover.

NOTE

The Power switch wiring will remain connected to the Power Supply/Z-Axis Board. If desired, the Power switch may be removed from the front panel.

4.2.4 VERTICAL PREAMP BOARD

Remove the two harness connectors and lift the PC assembly from the Vertical/Horizontal PC assembly.

4.2.5 VERTICAL/HORIZONTAL BOARD

Remove the CRT and Vertical Preamp Board. Remove the four screws securing the PC board to the bottom cover and lift the board from the instrument.

4.2.6 HIGH VOLTAGE ASSEMBLY

The High Voltage Assembly is secured to the top cover by four screws, one in each corner of the assembly. Remove these four screws and remove the assembly from the instrument.

4.3 REASSEMBLY

Reassembly is accomplished by reversing the disassembly procedures in Section 4.2.

When reinstalling the top cover, hold the right side bracket out so that it clears the front-panel controls. Start the 8-32 x 2¼ inch screws through the bottom cover into the top-cover-mounted screw extenders before installing the side cover extenders. The side cover extenders simply drop into the grooves in the top and bottom covers. (Install the edge with the long tabs first.)

Be sure the front and rear panels are in their respective slots in the top and bottom covers.

4.4 PERFORMANCE TESTS AND CALIBRATION

The following procedure is intended to ensure that the instrument meets its published specifications. Recommended test equipment is given in Table 4-1; control locations are given in Section 2 of this instruction manual. In general, calibration must be performed in the sequence given.

4.4.1 INITIAL SETUP

Turn the instrument upside down and remove the four 8-32x2¼ screws from the bottom cover. Turn the instrument right side up and lift the top cover just enough to slide out the side cover extenders. Remove the two screws securing the side shield to its mounting bracket and lift the shield out and place it on top of the top cover.

NOTE

A ground wire will remain attached to the shield.

Set the instrument controls as follows:

V/DIV	1 V/DIVISION
VERTICAL POSITION	mid-range
VERTICAL GAIN	full ccw
HORIZONTAL POSITION	mid-range
HORIZONTAL GAIN	full ccw
INTENSITY	full ccw
CONTRAST	full cw
VERTICAL INVERT	NOR
Z-AXIS Polarity	back

Table 4-1. Recommended Test Equipment

Equipment	*Critical Requirement*	*Recommended*
DVM	3½ digit	Fluke 8010A
High Voltage Voltmeter	Up to 8.5 kV	
Function Generator 1	Maximum output level >8 Vpp Maximum output frequency >20 kHz Sine wave	Wavetek 182A
Function Generator 2	Maximum output level >2 Vpp Maximum output frequency >20 kHz Sine wave	Wavetek 182A
Function Generator 3	Maximum output level >1 Vpp Maximum output frequency >10 MHz Sine, step sweep, and ramp functions	Wavetek 164

4.4.2 POWER SUPPLIES

Check for the following DC voltages on the Power Supply/Z-Axis Board:

SUPPLY	LOCATION	ACCEPTABLE RANGE(V)
+30	P4 Pin 12	+23.8 to +32.2
−30	P4 Pin 10	−23.8 to −32.2
+15	P4 Pin 5	+13.5 to +16.5
−15	P4 Pin 8	−13.5 to −16.5
+68	CR112 Cathode	+61.2 to +74.8

Adjust the High Voltage Adj control on the High Voltage Assembly to produce a reading of 310 V at the 310 V T.P. (J3 pin 7).

Using the high voltage meter, check the 8 kV supply at the CRT anode. It should read between +7.5 and +8.5 kV.

Check the voltage at J3 pin 6. It should be between 90 and 110 VDC.

4.4.3 YOKE

Using the function generator, apply a 100 Hz 2 Vpp sine wave to the HORIZONTAL INPUT. Increase the INTENSITY control setting until a trace appears. Adjust the HORIZONTAL GAIN and POSITION controls to produce a line which spans the width of the screen. Loosen the CRT yoke and mechanically rotate it on the CRT neck until the trace is horizontal (no tilt). Vary the HORIZONTAL POSITION control and verify that tuning the control ccw moves the trace to the viewer's left. Adjust the centering rings on the yoke to minimize bowing of the trace. Tighten the CRT yoke and re-check the alignment.

4.4.4 VERTICAL CURRENT LIMITING

Using the function generator, apply a 100 Hz 2 Vpp sine wave to the HORIZONTAL INPUT and a 1 kHz 1 Vpp sine wave to the VERTICAL INPUT. Set the VERTICAL GAIN control fully cw to produce a trace pattern which fills the screen. Monitor P1 pin 1 with the oscilloscope probe. Vary the amplitude of the signal to the VERTICAL INPUT and note the level at which the sine wave starts to clip. It should be between 1.0 and 1.5 Vp.

4.4.5 VERTICAL POLARITY CHECK

Remove the vertical input signal and center the trace with the VERTICAL POSITION control. Apply a signal with a positive DC offset to the VERTICAL input connector. The trace should move to the upper portion of the screen. Set the rear-panel VERTICAL INVERT switch to INV. The trace should move to the lower portion of the screen. Set the VERTICAL INVERT switch to NOR. The trace should move back to the upper portion of the screen. Remove the vertical input signal.

4.4.6 VERTICAL POSITION CONTROL

Set the amplitude of the vertical input signal such that the trace pattern fills the screen. Vary the VERTICAL POSITION control and verify that turning the control fully cw moves the trace off the screen to the top, while turning the control fully ccw moves the trace off the screen to the bottom.

4.4.7 VERTICAL DC BALANCE

Disconnect the vertical input signal. Using the function generator, apply a 100 Hz 2 Vpp sine wave to the HORIZONTAL INPUT connector and adjust the HORIZONTAL GAIN control to produce a 12 division wide trace. Set the VERTICAL GAIN control fully ccw and center the trace with the VERTICAL POSITION control. Set the VERTICAL GAIN control fully cw and center the trace with the Vert DC Bal adjustment located on the Vertical Pre-Amp Board. Repeat this procedure to produce a minimum of trace movement when the VERTICAL GAIN control is varied between its extremes.

4.4.8 VERTICAL GAIN

Set the VERTICAL GAIN control fully ccw and apply a 1 kHz 8 Vpp signal to the VERTICAL INPUT connector. Adjust the Vert Gain Cal control to produce a trace exactly 8 divisions tall.

4.4.9 VERTICAL BANDWIDTH

Set the VERTICAL GAIN control fully ccw. Adjust the vertical input signal to produce a trace pattern 10 divisions tall. Increase the vertical input frequency to 20 kHz. The trace pattern should be at least 7 divisions tall. Reset the vertical input signal to 1 Vpp at 1 kHz.

4.4.10 VERTICAL LINEARITY

Set the horizontal input signal to 1.5 Vpp at 300 Hz. Set the vertical input signal for a 1 msec/step step-up ramp. Adjust the rear-panel controls to produce horizontal bars at the upper middle of the CRT screen.

Using the VERTICAL POSITION control, set the bottom bar 7 divisions from the top of the screen. Adjust the VERTICAL GAIN control such that the

two lower-most bars are approximately 1 division apart. Adjust the Vertical Linearity control to obtain a constant interval between the bars. (This interval does not have to be 1 division.)

Using the VERTICAL POSITION control, move the trace pattern to he lower half of the CRT screen. The interval between the bars should still be constant and should not have changed.

Center the trace pattern on the screen. Adjust the HORIZONTAL GAIN control such that the horizontal bars extend the width of the screen. Check for bowing of the horizontal bars and make any necessary yoke adjustments (Section 4.3.2).

4.4.11 HORIZONTAL CURRENT LIMITING

Set the vertical input signal for 1 Vpp at 1 kHz (sine wave). Set the horizontal input signal for 2 Vpp at 100 Hz (sine wave). Set the HORIZONTAL GAIN control fully ccw. Adjust the HORIZONTAL POSITION and VERTICAL GAIN and POSITION controls such that the trace pattern just fills the CRT screen. Using the oscilloscope probe, monitor P1 pin 10 and adjust the horizontal input signal amplitude. Note the level at which the sine wave starts to clip. It should be between 1.65 and 2.65 Vp.

4.4.12 HORIZONTAL POSITION CONTROL

Set the amplitude of the horizontal input signal such that the trace pattern just fills the screen. Vary the HORIZONTAL POSITION control and verify that turning the control fully cw moves the trace off the screen to the viewer's right, while turning the control fully ccw moves the trace off the screen to the viewer's left.

4.4.13 HORIZONTAL GAIN

Set the HORIZONTAL GAIN control fully ccw. Verify that a horizontal input signal of between 1.5 and 2.0 Vpp will extend the trace pattern beyond the screen edge. Adjust the horizontal input signal such that the trace pattern just fills the screen. Verify that turning the HORIZONTAL GAIN control fully cw reduces the trace pattern to a vertical line.

4.4.14 HORIZONTAL BANDWIDTH

Set the HORIZONTAL GAIN control fully ccw, and adjust the horizontal input signal to produce a trace pattern 15 divisions wide. Increase the horizontal input frequency to 1.5 kHz. The trace pattern should be at least 10.5 divisions wide.

4.4.15 HORIZONTAL LINEARITY

Set the vertical input signal for 1.5 Vpp at 300 Hz (sine wave). Set the horizontal input signal for a 10 msec/step step-up ramp. Adjust the rear-panel controls to produce vertical bars at the upper right of the CRT screen.

Using the HORIZONTAL POSITION control, set the left-most bar 8 divisions from the right edge of the screen. Adjust the HORIZONTAL GAIN control such that the two left-most bars are approximately 1 division apart. Adjust the Horizontal linearity control to obtain a constant interval between the bars. (This interval does not have to be 1 division.)

Using the HORIZONTAL POSITION control, move the trace pattern to the left side of the screen. The interval between the bars should still be constant and should not have changed.

Center the trace pattern on the screen. Adjust the VERTICAL GAIN control such that the vertical bars extend the height of the screen. Check for bowing of the vertical bars and make any necessary yoke adjustments (Section 4.4.3).

4.4.16 AUTO BLANKING

Set the INTENSITY control such that the trace is just visible. Remove both the horizontal and vertical input signals and verify that the trace disappears. Reconnect the horizontal input signal and verify that a trace reappears. Disconnect the horizontal input signal and verify that the trace disappears. Reconnect the vertical input signal and verify that a trace reappears. Reconnect the horizontal input signal.

4.4.17 INTENSITY LIMIT AND FOCUS

Set the vertical input signal for a .6 Vpp at 20 Hz (square wave). Apply a ramp to the HORIZONTAL INPUT and adjust the ramp to produce a stable square wave pattern on the CRT screen. Adjust the rear-panel controls to produce an 8 x 10 division trace pattern.

Vary the INTENSITY control from minimum to maximum and note the percentage of blooming. Adjust the Intensity Limit control and vary the INTENSITY control again. Repeat this procedure to obtain the optimum combination of maximum trace intensity with minimum blooming. (The blooming should be $<1\%$.)

Adjust the Focus control for the sharpest trace, and check for crossover distortion.

4.4.18 Z-AXIS

Set the vertical input signal to 1 Vpp at 1 kHz (sine wave). Set the horizontal input signal to 2 Vpp at 100 Hz (sine wave). Adjust the rear-panel controls such that the trace pattern just fills the CRT screen.

Apply a 0.05 Vpp at 100 kHz sine wave to the Z-AXIS INPUT and set the CONTRAST control fully cw. While monitoring P4 pin 1 with the oscilloscope probe, adjust the Z-axis input signal to produce an 18.0 Vpp sine wave at P4 pin 1. The Z-axis input signal should be <1 Vpp.

Set the Z-axis input frequency to 1 MHz. The signal at P4 pin 1 should be >16.0 Vpp (<1 dB down). Set the Z-axis input frequency to 3 MHz. The signal at P4 pin 1 should be >12.7 Vpp (<3 dB down). Set the Z-axis input frequency to 10 MHz. The signal at P4 pin 1 should be >5.7 Vpp (<10 dB down).

Set the Z-Axis Polarity switch to its "up" position, and recheck the Z-axis bandwidth. There should be no variation from the previous readings.

Set the Z-Axis Polarity switch to its "down" position. The Performance Test/ calibration procedure is complete.

4.5 TROUBLESHOOTING

Effective troubleshooting requires a thorough understanding of the block diagram and circuit descriptions located in Section 3 of this manual. The Performance Tests And Calibration procedure (Section 4.4) will aid in localizing the trouble symptom to a particular assembly. Once this has been accomplished, the assembly can be replaced or repaired. In general, it is preferable to replace a defective assembly.

Equipment troubles are frequently due simply to improper control settings; therefore, before engaging in a troubleshooting procedure, be sure all controls are set in proper operating position. Refer to Section 2 of this manual for complete explanation of each control's function along with typical operating instructions.

After verifying that the trouble is not improper setting of the controls or test set-up, make a thorough visual inspection of the instrument for such obvious defects as loose or missing screws, broken wires, loose connectors, and burned or broken components. After localizing the problem, voltage and resistance checks will help find the defective component.

NOTE

A problem in a power supply may cause many symptoms pointing to other areas, and should be checked when the symptom does not indicate a specific problem.

SECTION 5
REPLACEABLE PARTS

5.1 INTRODUCTION

This section contains lists of all replaceable parts for the instrument.

For an assembly containing one or more subassemblies, the assembly list appears first, and is followed by the subassembly lists.

The lists appear in the following order.

PARTS LIST	ASSEMBLY
1010-00-0201	DISPLAY SCOPE
1115-00-0029	HIGH VOLTAGE ASSEMBLY
1218-00-1390	HIGH VOLTAGE BOARD
1110-00-1360	P.S./Z-AXIS BLANKING BOARD
1110-00-1351	VERTICAL/HORIZONTAL AMP BOARD
1110-00-1420	PRE-AMPLIFIER ASSEMBLY
1111-00-0132	CHASSIS ASSEMBLY
1219-00-0243	HARNESS A
1219-00-0368	HARNESS B
1219-00-0369	HARNESS C

5.2 MANUFACTURERS CODE

The following code is used on the parts lists to identify the manufacturer.

ABBR.	NAME.....	CITY.....	ST	FSCM.
A-B	ALLEN-BRADLEY	MILWAUKEE	WI	01121
A-D	ANALOG DEVICES	CAMBRIDGE	MA	24355
A-H	ARROW HART, INC.	KETTERING	OH	07858
A-I	ALAN INDUSTRIES	COLUMBUS	IN	52750
A-M	AMERICAN MAGNETICS	CARTERVILLE	IL	12715
A-P	AMERICAN PLASTICRAFT CO.	CHICAGO	IL	53628
A-Z	AMERICAN ZETTLER, INC.	IRVINE	CA	26806
ABAC	ABACUS PACKAGING CO.	CHICAGO	IL	
ACEIN	ACE INDUSTRIAL HDWR.	CAMDEN	NJ	
ACI	ADVANCE COMPONENTS, INC.	CENTERBROOK	CT	28102
AEG-T	AEG-TELEFUREN CORP.	SOMERVILLE	NJ	24972
AEP	APPLIED ENG PRODUCTS	NEW HAVEN	CT	19505
AER	AVX CERAMICS	MYRTLE BEACH	SC	96095
AERTK	AERTECH INDUSTRIES	SUNNYVALE	CA	21847
AFE	ACCESSORIES FOR ELECTRONICS	BALDWIN	NY	
AHAM	AHAM COMPANY	AZUSA	CA	53094
AIN	ALPHA INDUSTRIES, INC.	WOBURN	MA	17540
ALC	ALCO ELECTRONICS PRODUCTS	NORTH ANDOVER	ME	95146
ALLPL	ALL PLASTICS,INC.	INDIANAPOLIS	IN	
ALMPT	ALPHA METALS, INC	JERSEY CITY	NJ	96613
AMATM	AMATOM ELEC HDWE CO	NEW HAVEN	CT	
AMD	ADVANCED MICRO DEVICES INC.	SUNNYVALE	CA	34335
AMELC	AMERICAN ELECTRIC CORDSETS	BENSENVILLE	IL	0
AMP	AMP, INC.	HARRISBURG	PA	00779
ANSLY	ANSLEY ELECTRONICS LTD	DOWNSVILLE, ONT., CANADA	**	
ANZAC	ADAMS-RUSSELL,ANZAC DIV	BURLINGTON	MA	
APL	AMPHENOL CONNECTOR SYSTEMS	BROADVIEW	IL	74868
APP	A-P PRODUCTS	PAINESVILLE	OH	0
APX	AMPEREX ELECTRONIC CORP.	SLATERSVILLE	RI	25403
ARC	ARCO ELECTRIC PRODUCTS	SHELBYVILLE	IN	24652
ARIES	ARIES ELECTRONICS CORP.	FRENCHTOWN	NJ	
ARN	ARNOLD ENGINEERING CO.	MARENGO	IL	95566
AROMT	AROMAT CORP.	ELK GROVE VILLAGE	IL	
ARW-M	ARROW-M CORP	CARSON	CA	
ASBAG	ASSOCIATED BAG CO.	MILWAUKEE	WI	
ASC	ASSOCIATED SPRING	BRISTOL	CT	92830
ASE	AIRCO SPEER ELECTRONICS	ST. MARYS	PA	06560
ASM	ACCURATE SCREW MACHINE CO	NUTLEY	NJ	51506
ASTID	ASTRO INDUSTRIES	DAYTON	OH	29365
AT/IN	ATLANTIC INDIA RUBBER CO	CHICAGO	IL	70485
ATC	AMERICAN TECHNICAL CERAMICS	HUNTINGTON STATN	NY	29990
ATR	ATR COIL CO.	BLOOMINGTON	IN	XXXXX
AUGAT	AUGAT, INC.	ATTLEBORO	MA	91506
AULT	AULT INC.	MINNEAPOLIS	MN	14310
AUTCN	AUTOMATIC CONNECTOR, INC.	COMMACK	NY	94375
AUTCP	AUTOMATION COMPONENTS	PECKVILLE	PA	33498
AVDEL	AVDEL FASTENER SYS.	PARSIPPANY	NJ	19738
AVT	AVANTEK, INC.	SANTA CLARA	CA	24539
AWC	ALPHA WIRE	ELIZABETH	NJ	92194

ABBR.	NAME.....	CITY.....	ST	FSCM.
B-T	BEK-TEK, INC.	READING	PA	XXXXX
B-W	BARKER & WILLIAMSON	BRISTOL	PA	05690
BEARI	BEARINGS, INC.	CLEVELAND	OH	05469
BEK	BECKMAN INSTRUMENTS, INC.	FULLERTON	CA	73138
BEL	BELDEN CORP.	GENEVA	IL	70903
BER	BERG ELECTRONICS	NEW CUMBERLAND	PA	22526
BERQ	BERGQUIST	MINNEAPOLIS	MN	
BGH	BEECH GROVE HARDWARE	BEECH GROVE	IN	XXXXX
BIRT	BIRTCHER CORP	EL MONTE	CA	33962
BIVAR	BIVAR INC	SANTA ANA	CA	32559
BOKER	BOKER'S INC.	MINNEAPOLIS	MN	85446
BORDN	BORDEN INC.	COLUMBUS	OH	32283
BOU	BOURNS, INC.	RIVERSIDE	CA	80294
BRAUN	BRAUN MFG CO	CHICAGO	IL	93785
BREZ	BREEZE CORPORATIONS, INC.	UNION	NJ	08484
BSCAN	B-SCAN, INC.	PHILADELPHIA	PA	32198
BSHP	BISHOP GRAPHICS, INC.	WESTLAKE VILLAGE	CA	34730
BUCK	BUCKEYE STAMPING CO.	COLUMBUS	OH	21604
BUD	BUD RADIO, INC.	WILLOUGHBY	OH	71218
BURND	BURNDY CORP.	NORWALK	CT	09922
BUS	BUSSMAN MFG.	ST. LOUIS	MO	71400
BWC	BARON WIRE AND CABLE CORP.	CHICAGO	IL	72622
C-A	CIRCUIT ASSEMBLY CORP	COSTA MESA	CA	52072
C-D	CORNELL DUBILIER ELECT DIV	NEWARK	NJ	14655
C-E	CLINTON ELECTRONICS	ROCKFORD	IL	54972
C-H	CUTLER-HAMMER, INC.	MILWAUKEE	WI	55841
C-I	COMPONENTS, INC.	BIDDEFORD	ME	17554
C-J	TRW/CINCH	ELK GROVE VILLAGE	IL	71785
C-K	C & K COMPONENTS, INC.	WATERTOWN	MA	09353
C-L	CENTRALAB DIV.	MILWAUKEE	WI	71590
C-M	C-M			
C-W	C-W INDUSTRIES	WARMINSTER	PA	79727
CAE	CAPAR COMPONENTS CORP	MELVILLE	NY	
CAI	CUSTOM ACCESSORIES, INC.	SKOKIE	IL	XXXXX
CAM	CAMBION	CAMBRIDGE	MA	71279
CAR	CARLING ELECTRIC, INC.	WEST HARTFORD	CT	73559
CBLWV	CABLEWAVE SYSTEMS, INC.	NORTH HAVEN	CT	16733
CBRDM	CARBORUNDUM INSUL DIV	NIAGARA FALLS	NY	
CCM	CORCOM, INC.	LIBERTYVILLE	IL	05245
CDC	COMPONENT DEVELOPMENT CORP.	CARSON	CA	XXXXX
CECO	CENTRAL COIL CO.	BRAZIL	IN	XXXXX
CFI	CIRCUIT FUNCTIONS INC.	NEWBURY PK	CA	32499
CGW	CORNING GLASS WORKS	CORNING	NY	24546
CHE	CHERRY ELECTRICAL PRODUCTS	WAUKEGAN	IL	01963
CHEMP	CHEMPLAST,INC.	WAYNE	NJ	0
CHLAR	CHARLES LARSON CO.	STERLING	IL	
CHOM	CHOMERICS INC.	WOBURN	MA	18565
CHRY	CHRYSLER CORP.	DETROIT	MI	12204
CHTFD	CHATFIELD PAPER	CINCINNATI	OH	97361
CIMCO	CIMCO WIRE AND CABLE INC.	ALLENDALE	NJ	XXXXX
CINOX	CINOX CORP	CINCINNATI	OH	58997
CKI	CTS KNIGHTS, INC.	SANDWICH	IL	75378
CLA	CLAIREX CORP.	MT. VERNON	NY	03911

ABBR.	NAME.....	CITY.....	ST	FSCM.
CLAR	CLAROSTAT MFG. CO	DOVER	NH	12697
CLCFT	COILCRAFT	CARY	IL	
CLFRM	COILFORM	GENEVA	IL	20254
CLFX	COLE-FLEX CORP.	BABYLON	NY	56352
CLMRK	CALMARK CORP	SAN GABRIEL	CA	52094
CMLC	CAMLOC FASTENER	PARAMUS	NJ	
CNCRD	CONCORD ELEX	NEW YORK	NY	18310
CNTRN	CENTURION	*****	**	
COL	COLLMER SEMICONDUCTORS INC	DALLAS	TX	
COORS	COORS PORCELAIN CO	GOLDEN	CO	
CPKG	CREATIVE PKG DIV	INDIANAPOLIS	IN	46203
CPLRD	COMPLETE-READING ELEC.CO.	DALLAS	TX	02358
CRDWL	CARDWELL CONDENSER CORP	LINDENHURST	NY	88356
CRMLY	CERMALLOY	WEST CONSHOHOCKEN	PA	
CRTR	CORE-TRONICS	ORANGE	NJ	29324
CSDC	CONDITIONING SEMICNDTR DVS	WAYNE	NJ	
CTC	COMMUNICATIONS XISTOR CORP	SAN CARLOS	CA	
CTS	CHICAGO TELEPHONE SYSTEMS	CHICAGO	IL	71450
CTS-E	CTS OF ELKHART	ELKHART	IN	71450
CTS-F	C.T.S. OF FAIRBERRY	FAIRBERRY	IL	71450
CTS-K	CTS OF KEENE	PASO ROBLES	CA	11237
CTSBR	CTS OF BERNE	BERNE	IN	11236
CTSBV	CTS OF BROWNSVILLE	BROWNSVILLE	TX	34263
CW/AL	C.W./ALPHA	SOUTHAMPTON	PA	
DAL	DALE TECHNOLOGY CORP.	HARTSDALE	NY	XXXXX
DATEL	DATEL SYSTEMS, INC.	MANSFIELD	MA	50721
DAV	HARRY DAVIES MOLDING CO.	CHICAGO	IL	72512
DAYTN	DAYTON ELECTRIC CO.	CHICAGO	IL	16327
DEL	DELEVAN DIV.	EAST AURORA	NY	XXXXX
DEN	DENNISON MFG. CO.	FRAMINGHAM	MA	16956
DEW	DEWIRE FABRICATING CORP.	LOWELL	MA	13161
DGTRN	DIGITRAN CO.	PASADENA	CA	
DILEC	DILECTRON	MONROVIA	CA	0
DIO	DIODES, INC.	CHATSWORTH	CA	12060
DIXON	DIXON INDUSTRIES INC.	BRISTOL	RI	04813
DK-WR	DAKO-WARE	CHICAGO	IL	
DLGHT	DIALIGHT	BROOKLYN	NY	72619
DLI	DIELECTRIC LABORATORIES INC	CAZENVIA	NY	55153
DLTEM	DELTA ELECTRONICS MFG CO	BEVERLY	MA	00795
DM-GY	DIMCO-GRAY	CENTERVILLE	OH	80813
DNTCH	DONTECH, INC.			
DRA	DRAKE MANUFACTURING CO.	HARWOOD HEIGHTS	IL	71744
DRMYR	DORMEYER	ROCKVILLE	IN	73662
DUPNT	E.I.DUPONT DENEMOURS & CO	WILMINGTON	DE	
DYNR	DYNEER CORP.	CHATSWORTH	CA	
E-C	ELECTRONIC CRYSTALS	KANSAS CITY	MO	18853
E-I	ELECTRICAL INDUSTRIES,INC.	MURRAY HILL	NJ	20093
E-M	ELECTRA/MIDLAND CORP.	MINERAL WELLS	TX	XXXXX
EATON	EATON CORP.	SUNNYVALE	CA	34657
EBY	EBY COMPANY	PHILADELPHIA	PA	72825
ECKDT	ECKARDT LABORATORIES	ORANGE	CA	
ECMC	ELECTRI-CORD MFG. CO. INC.	WESTFIELD	PA	XXXXX

ABBR.	NAME.....	CITY.....	ST	FSCM.
EDAC	EDAC, INC.	DON MILLS, ONT., CANADA	**	31781
EECO	EECO, INC.	SANTA ANA	CA	97525
ELC-I	ELECTRA	CUMBERLAND	IN	
ELCO	ELCO INDUSTRIES	ROCKFORD	IL	83486
ELDRE	ELDRE COMPONENTS, INC	ROCHESTER	NY	19648
ELEXP	ELECT EXPEDITERS	MILWAUKEE	WI	
ELFX	ELECTRO-FLEX HEAT INC.	BLOOMFIELD	CT	02728
ELHDW	ELECTRONIC HARD	FARMINGDALE	NY	
ELNA	ELNA	CARSON	CA	
ELOCB	ELECTRO CUBE, INC.	SAN GABRIEL	CA	14752
EM-CM	EMERSON & CUMING,INC	CANTON	MA	
EMRON			S	0
ENTHN	ENTHONE INC.	NEW HAVEN	CT	02258
EPITK	EPITEK ELECTRONICS	KANATA,ONT,CANADA	**	37907
EPOXT	EPOXY TECHNOLOGY, INC.	BILLERICA	MA	33246
ETC	ELECTRONIC TRANSISTOR CORP.	FLUSHING	NY	12045
ETP	ERIE TECHNOLOGICAL PRODUCTS	ERIE	PA	72982
EVRDY	EVEREADY	NEW YORK	NY	
EXAR	EXAR INTEGRATED SYSTEMS	SUNNYVALE	CA	52063
EZLOK	E-Z LOK	GARDENIA	CA	
F-K	THERMWELL PRODUCTS, INC.	FRAMINGHAM	MA	XXXXX
F-S	FEDERAL SCREW	CHICAGO	IL	73734
FAN	FANCOURT & CO.	GREENSBORO	NC	XXXXX
FASTX	FASTEX DIV.,ILL.TOOL WORKS	DES PLAINES	IL	0
FCD	FAIRCHILD	MOUNTAIN VIEW	CA	07263
FCI	FILM CAPACITORS, INC.	PAS SALC	NJ	00686
FJTSU	FUJITSU AMERICA, INC.	LAKE BLUFF	IL	
FNWL	FENWAL	FRAMINGHAM	MA	15801
FRDKS	FREDERICKS CO.	HUNTINGDON VALLEY	PA	
FRK	FRAKO	FRANKFORT, GER.	**	XXXXX
FRRNT	FERRANTI ELECTRIC, INC.	COMMACK	NY	22119
FRTE	FAIR RITE PRODUCTS CORP.	WALLKILL	NY	34899
FRXC	FERROXCUBE DIVISION	SAUGERTIES	NY	02114
FUT	FUTABA			
G-E	GENERAL ELECTRIC	INDIANAPOLIS	IN	24446
G-H	GRAYHILL, INC.	LA GRANGE	IL	81073
G-I	GEN'L INSTRUMENT SEMICNDTR	HICKSVILLE	NY	14963
G-T	GRAND TRANSFORMERS	GRAND HAVEN	MI	02459
GAL	GALILEO ELECTRO-OPTICS	STURBRIDGE	MD	28719
GATES	GATES ENERGY PROD.	DENVER	CO	57053
GBN	GILBERT ENGINEERING CO.,INC	PHOENIX	AZ	82316
GCE	GC ELECTRONICS	ROCKFORD	IL	80112
GHZ	GHZ DEVICES, INC.	CHELMSFORD	MA	
GLOBE	GLOBE	MILWAUKEE	WI	
GNATR	GENERAL ATRONICS CORP.	PHILADELPHIA	PA	07407
GOU	GOULD, INC.	ST. PAUL	MN	55857
GRIES	GRIES REPRODUCER	NEW ROCHELLE	NY	05673
GRIP	GRIPMASTER CO.	MARLBORO	NJ	XXXXX
GRVCO	GROVE COMPANY	DAYTON	OH	
GUDL	GUDEBROD BROS. SILK CO.	CHICAGO	IL	XXXXX

ABBR.	NAME.....	CITY.....	ST	FSCM.
GWNDA	GOWANDA ELEX CORP	GOWANDA	NY	
H-P	HEWLETT-PACKARD	INDIANAPOLIS	IN	28480
HARTW	HARTWELL CORP.	PLACENTIA	CA	0
HDMLD	DAVIES H MOLDING	CHICAGO	IL	
HEL	HELIPOT	ANAHEIM	CA	XXXXX
HEY	HEYMAN MFG. CO.	WAUKESHA	WI	28520
HGHS	HUGHES SOLID-STATE PROD	NEWPORT BEACH	CA	
HHS	HERMAN H. SMITH, INC.	BROOKLYN	NY	83330
HI-G	HI-G INC	WINDSOR LOCKS	CT	02289
HIT	HITACHI AMERICA, LTD.	SAN FRANCISCO	CA	XXXXX
HMLN	HAMLIN	LAKE MILLS	WI	12617
HOLGW	HOLLINGSWORTH SLDRLS TERM.	POTTSTOWN	PA	14726
HOLUB	HOLUB DISTRIBUTING CO.	NEWPORT	KY	XXXXX
HRMTT	HERMETITE CORP.	AVON	MA	04302
HSD	HARRIS CORP. SEMICDR. DIV.	MELBOURNE	FL	27410
HUD	HUDSON TOOL & DIE CO.	NEWARK	NJ	02875
HWDN	HOWDEN CO.	NEWARK	OH	
HY/PL	HYDRO PLASTICS INC.	GEORGETOWN	KY	XXXXX
HYSOL	HYSOL CORP	INDUSTRY	CA	12405
HYSYS	HYBRID SYSTEMS	BEDFORD	MA	33256
HYT	HYTRONICS	PINELLAS PARK	FL	29525
IBNCO	INDIANA BOLT AND NUT CO.	INDIANAPOLIS	IN	
ICI	ILLINOIS CAPACITOR INC.	MORTON GROVE	IL	74840
ICO-R	ICO-RALLY	PALO ALTO	CA	
IDC	INTL DIODE CORP.	HARRISON	NJ	16068
IEE	INDUSTRIAL ELECTRONIC ENG	NORTH HOLLYWOOD	CA	05464
IERC	INT'L ELEC. RESEARCH CORP.	BURBANK	CA	98978
INDCP	INDUCTIVE COMPONENTS	HAUPPAUGE	NY	25159
INDEC	INDUSTRIAL ELECTRONIC HDWR.	NEW YORK	NY	97913
INDFS	INDUSTRIAL FASTENERS CORP.	PORT WASHINGTON	NY	84992
INDGL	INDIANA GENERAL	KEASBEY	NJ	72656
INLOK	INTERLOK/WM J PURDY CO.	BURLINGAME	CA	55951
INT	INTERSIL, INC.	CUPERTINO	CA	32293
INTEL	INTEL CORP	SANTA CLARA	CA	34649
INWEB	INTERNATIONAL WEBBING	WHITEHALL	PA	32860
IRC	INTERNATIONAL RESISTANCE CO	PHILADELPHIA	PA	75042
IREC	INT'L RECTIFIER CORP.	LOS ANGELES	CA	81483
ISTMP	ISOTEMP RESEARCH, INC.	CHARLOTTESVILLE	VA	31785
ITRON	ISE ELECTRONICS	ISE,JAPAN	**	0
ITT	INT'L TELEPHONE & TELEGRAPH	W. PALM BEACH	FL	XXXXX
ITT-C	ITT-CANNON	FOUNTAIN VALLEY	CA	71468
JAMES	JAMES ELECTRONICS	CHICAGO	IL	12749
JAN	JAN HARDWARE MFG. CO.	LONG ISLAND CITY	NY	99813
JEF	JEFFERS	DUBOIS	PA	97469
JEFWC	JEFFERSON WIRE AND CABLE	WORCHESTER	MA	07883
JEW	JEWELL ELECTRICL INST	MANCHESTER	NH	
JFD	JFD ELECTRONICS	BROOKLYN	NY	73899
JFW	JFW INDUSTRIES	BEECH GROVE	IN	56532
JHSN	JOHANSON MFG. CORP.	BOONTON	NJ	91293
JON	E.F. JOHNSON CO.	WASECA	MN	74970

ABBR.	NAME.....	CITY.....	ST	FSCM.
JUDD	JUDD WIRE DIV. ECC	TURNERS FALLS	MA	12703
K-L	KERRIGAN LEWIS MFG.	CHICAGO	IL	73920
K-S	K & S ENGINEERING CO.	CHICAGO	IL	22376
KDI-P	KDI-PYROFILM CORP.	WHIPPANY	NJ	03888
KEENE	KEENE CORP.	NEWARK	DE	52869
KEM	KEMTRON ELECTRON PRODUCTS	NEWBURYPORT	MA	92703
KEY	KEYSTONE ELECTRONIC CORP.	NEW YORK	NY	91833
KID	KIDCO, INC.	MEDFORD	NJ	12126
KIN	KINGS ELECTRONICS	TUCKAHOE	NY	91836
KNYO	KAMAYA OHM	JAPAN	**	
KRYST	KRYSTINEL	PATERSON	NJ	29251
KSTR	KESTER SOLDER DIV.	CHICAGO	IL	09185
KSW	KSW ELECTRONICS	BURLINGTON	MA	52673
KUL	KULKA ELECTRIC CORP.	MT. VERNON	NY	75382
KYCRA	KYOCERA INTERNATIONAL	SAN DIEGO	CA	
LAMB	LAMB INDUSTRIES, INC.	PORTLAND	OR	
LAUREN	LAUREN MFG CO.	NEW PHILADELPHIA	OH	56329
LEYSE	LEYSE ALUMINUM CO.	KEWANEE	WI	20218
LIT	LITTELFUSE, INC.	DES PLAINES	IL	75915
LNMST	LINEMASTER SWITCH CORP.	WOODSTOCK	CT	97918
LOCTT	LOCTITE CORP.	NEWINGTON	CT	05972
LRC	LRC ELECTRONICS, INC.	HORNELL	NY	16157
LSI	LUMINESCENT SYSTEMS, INC	LEBANON	NH	16157
LTRNX	LITRONIX	CUPERTINO	CA	50579
M-A	MICROWAVE ASSOCIATES	BURLINGTON	MA	96341
M-D	MILLER DIAL & NAMEPLATE CO.	EL MONTE	CA	74072
M-E	MEPCO ELECTRA, INC.	MORRISTOWN	NJ	19701
M-O	ILLUMINATED PRODUCTS INC.	SANTA ANA	CA	XXXXX
M-P	MICRO PLASTICS INC.	CHATSWORTH	CA	31223
MAL	MALLORY CONTROLS CO.	FRANKFORT	IN	90201
MAND	MANDEX	CHICAGO	IL	98278
MARQ	J. & J. MARQUARDT	TUTTLINGEN, GER.	**	XXXXX
MCMTL	MICROMETALS, INC	ANAHEIM	CA	12856
MCREL	MICRO ELEX LTD	HONG KONG	**	
MD-AM	MID AMERICA	CHICAGO	IL	
MDC	MAIDA DEVELOPMENT CO.	HAMPTON	VA	91784
MDLRS	MIDLAND ROSS	CINCINNATI	OH	57951
MDTC	MODUTEC	NORWALK	CT	32171
MFLCO	MAURICE FRANKLIN LOUVER CO.	PROVIDENCE	RI	
MILN	MILLEN MFG. CO.	NEW YORK	NY	XXXXX
MILSP	MILITARY SPECIFICATION	WASHINGTON	DC	81349
MIN-C	MINI-CIRCUITS	BROOKLYN	NY	15542
MINIS	MINI SYSTEMS	NORTH ATTLEBORO	MA	50316
MINOR	MINOR RUBBER CO.	BLOOMFIELD	NJ	76385
MITEK	MITEK	LEXINGTON	MA	0
MLRJW	J.W. MILLER	COMPTON	CA	96304
MMM	3M COMPANY	ST. PAUL	MN	
MNO	MONSANTO COMM. PROD. DIV.	PALO ALTO	CA	50522
MOL	MOLEX PRODUCTS	LISLE	IL	27264

ABBR.	NAME.....	CITY.....	ST	FSCM.
MORAD	MORGAN ADHESIVES	STOW	OH	17452
MOSTK	MOSTK CORP.	CARROLLTON	TX	50088
MOT	MOTOROLA SEMI. PROD. DIV.	INDIANAPOLIS	IN	04713
MOUS	MOUSER ELECTRONICS	LAKESIDE	CA	50811
MRM	M. ROSS MASON	INDIANAPOLIS	IN	
MRO	MICRO SWITCH DIV.	FREEPORT	IL	91929
MRRUB	MARION RUBBER PROD.	INDIANAPOLIS	IN	
MSN	MICROSONICS DIV.	WEYMOUTH	MA	11869
MSP	MICRO SEMICONDUCTOR CORP.	SANTA ANA	CA	14552
MTSBI	MITSUBISHI ELEC. CORP.	SUNNYVALE	CA	00000
MULSO	MULTICORE SOLDERS LTD.	WESTBURY	NY	03051
MURA	MURA	WESTBURY	NY	32539
MURGA	MURATA-GEORGIA	MARIETTA	GA	51406
MWS	MAGNET WIRE SUPPLY CO.	CHATSWORTH	CA	51668
MWS-P	MWS PRECISION WIRE INDUS	WESTLAKE VILLAGE	CA	
MYERS	MYERS SPRING CO.	LOGANSPORT	IN	91956
N-T	NATIONAL TEL-TRONICS	LAREDO	TX	XXXXX
NAT	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA	CA	27014
NCC	NATIONAL CERAMIC CO	TRENTON	NJ	76626
NCSVC	NATL COM SERV.	WILLOW GROVE	PA	
NEC	NIPPON ELECTRIC CO.	TOKYO, JAPAN	**	18324
NEL	NATIONAL ENGINEERING LABS	INDIANAPOLIS	IN	XXXXX
NEMCO	NEMCO METALS, INC	MANVILLE	RI	
NEW	NEWARK ELECTRONICS	INDIANAPOLIS	IN	XXXXX
NHWC	NEW HAVEN WIRE & CABLE	NEW HAVEN	IN	XXXXX
NICHN	NICHICON (AMERICA) CORP.	SCHAUMBURG	IL	55680
NMB	NMB CORP.	ARLINGTON HEIGHTS	IL	60005
NMC	MAGNUM MICROWAVE CORP.	SUNNYVALE	CA	59277
NPC	NUCLEONIC PRODUCTS CO.	CANOGA PARK	CA	0
NRTLK	NORTHLAKE ENG, INC	ANTIOCH	IL	50638
NYLO	NYLOMATIC	MORRISVILLE	PA	XXXXX
O-G	OPTI-GAGE INC.	DAYTON	OH	XXXXX
O-S	OMNI SPECTRA INC.	FARMINGTON	MI	16179
OAK	OAK INDUSTRIES INC.	CRYSTAL LAKE	IL	76854
OHM	OHMITE MFG. CO.	SKOKIE	IL	44655
OMEGA	OMEGA WIRE & CABLE	HARLEYSVILLE	PA	XXXXX
OPTO	OPTO ELECTRONICS INC	FT LAUDERDALE	FL	
OPTRN	OPTRON INC.	CARROLLTON	TX	XXXXX
P-B	POTTER AND BRUMFIELD	PRINCETON	IN	77342
P-C	POWER COMPONENTS	WOODLAND HILLS	CA	XXXXX
P-K	PARKER KALON CORP.	CLIFTON	NJ	XXXXX
P-T	PENN TUBE PLASTICS CO.	CLIFTON HEIGHTS	PA	0
P-U	PROJECTS UNLIMITED INC.	DAYTON	OH	XXXXX
POLPH	POLYPHASE INSTR. CO.	BRIDGEPORT	PA	0
PACTC	PACTEC DIV.	PHILADELPHIA	PA	
PAM	PAMOTOR DIV.	BURLINGAME	CA	23936
PAND	PANDUIT CORP.	TINLEY PARK	IL	06383
PARA	PARAMETRIC INDUSTRIES	NORTHFIELD	IL	XXXXX
PCC	PANEL COMPONENTS CORP.	BERKELEY	CA	00000
PEC	PACIFIC ELECTRICORD CO.	GARDENA	CA	80126
PEM	PENN ENGRG & MANUF CO.	DANBORO	PA	
PFZR	PFIZER,INC,	NEW YORK	NY	86491

ABBR.	NAME.....	CITY.....	ST	FSCM.
PHC	PHILADELPHIA HANDLE CO.	CAMDEN	NJ	XXXXX
PHILP	PHILPOTT RUBBER CO.	CLEVELAND	OH	86510
PIC	PIHER INTERNATIONAL CORP.	ARLINGTON HEIGHTS	IL	54869
PIEZO	PIEZO TECHNOLOGIES, INC.	ORLANDO	FL	
PLI	PRECISION LAMP, INC.	MT. VIEW	CA	48451
PLSSY	PLESSEY ENG.	SCHILLER PARK	IL	55112
PLSTI	PLASTIC TECHNIQUES, INC	NEW BOSTON	NH	
PLYCL	POLYCLAD LAMINATES	SOUTHFIELD	MI	
PMCL	PERMACEL DIV.	NEW BRUNSWICK	NJ	99742
PMI	PRECISION MONOLITHICS INC.	SANTA CLARA	CA	06665
PNSNC	PANASONIC			
POLPH	POLYPHASE INSTR,CO	BRIDGEPORT	PA	98330
POM	POMONA ELECTRONICS CO.,INC	POMONA	CA	05276
PREH	PREH VERT,MBH	GERMANY	**	
PRMD	PYRAMID INDUSTRIES, INC.	PHOENIX	AZ	XXXXX
PRRES	PRECISION RESISTIVE PRDTS	MEDIAPOLIS	IA	
PRSLK	PRESTO-LOCK	GARFIELD	NJ	77386
PRSN	PRECISION TUBE CO., INC	NORTH WALES	PA	82413
PTN	PENN TRAN CORP.	BELLEFONT	PA	XXXXX
PWRMT	POWER-MATE CORP.	HACKENSACK	NJ	
PYRO	PYROFILM CORP.	WHIPPANY	NY	XXXXX
PYTT	PYTTRONICS INDUSTRIES, INC.	MONTGOMERYVILLE	PA	31924
Q-C	QUALITY COMPONENTS	ST. MARYS	PA	95121
R-E	ROBISON ELECTRONICS	SAN LUIS OBISPO	CA	
R-N	ROBINSON-NUGENT	NEW ALBANY	IN	0
R-OHM	R-OHM	IRVINE	CA	57668
RAF	RAF ELECTRONIC HDWE	STRAFFORD	CT	
RAWST	RAW STOCK	*****	**	
RAY	RAYTHEON	INDIANAPOLIS	IN	49956
RAYVC	RAY-O-VAC/DV	MADISON	WI	
RBRCT	RUBBERCRAFT	*****	**	
RCA	RCA	CAMDEN	NJ	02735
RCHLK	RICHLOK CORP	CHICAGO	IL	
REL	RELIANCE MICA CO.	BROOKLYN	NY	08530
RGNCY	REGENCY ELECTRONICS, INC.	INDIANAPOLIS	IN	
RGR	ROGERS CORP.	CHANDLER	AZ	31745
RICH	RICHCO PLASTIC CO.	CHICAGO	IL	06915
RICHM	RICHARDS METAL PRODUCTS	WOLCOTT	CT	19076
RMC	RADIO MATERIALS CORP.	CHICAGO	IL	82560
RMF	RMF PRODUCTS INC.	BATAVIA	IL	XXXXX
ROCKW	ROCKWELL INTL.	ANAHEIM	CA	33085
ROGAN	ROGAN CORP.	NORTHBROOK	IL	86797
ROTRN	ROTRON INC.	WOODSTOCK	NY	82877
RPBLC	REPUBLIC ELECTRONICS CORP	PATTERSON	NJ	
RSSLL	RUSSELL	OCEANSIDE	NY	24324
RTNA	ROSENTHAL TECHNIK,N.A.	PROVIDENCE	RI	
S-C	SPECIALTY CONNECTOR	INDIANAPOLIS	IN	24931
S-G	STANDARD GRIGSBY	AURORA	IL	82104
S-I	SWITCHCRAFT, INC.	CHICAGO	IL	82389
S-S	SERVICE SUPPLY	INDIANAPOLIS	IN	XXXXX

ABBR.	NAME.....	CITY.....	ST	FSCM.
S-T	SARKES TARZIAN	BLOOMINGTON	IN	51589
SAE	STANFORD APPLIED ENG	SANTA CLARA	CA	
SAGE	SAGE LABORATORIES, INC.	NATIC	MA	
SAYRO	SAYROSA ENGINEERS LTD.	ALTON, HANTS, U.K.	**	04180
SCBE	SCANBE DIVISION	EL MONTE	CA	18677
SCC	STACKPOLE CARBON CO.	ST. MARYS	PA	78488
SCX	SILICONIX INC.	SANTA CLARA	CA	17856
SEAST	SEASTROM MFG. CO.	GLENDALE	CA	86928
SECR	SECOR INC.	WESTWOOD	NJ	0
SEL	SEALECTRO CORP.	MAMARONECK	NY	98291
SEM	SEMTECH	NEWBURY PARK	CA	14099
SEMTX	SEMTEX	DAYTON	OH	0
SENST	SENSOTEC INC	COLUMBUS	OH	51518
SGM	SIGMA INSTRUMENTS	BRAINTREE	MA	72421
SGS-A	SGS-ATES COMP ELET SPA	AGRATE BRIANZE, ITALY	**	
SHAM	SHAMROCK PLASTICS & RUBBER	INDIANAPOLIS	IN	XXXXX
SHDW	I.E.E. SCHADOW	EDEN PRAIRIE	MN	
SHKMN	SHACKMAN INSTRUMENTS	CHESHAM, ENGLAND	**	0
SHURE	SHURE BROS, INC.	EVANSTON	IL	
SIEM	SIEMENS	ISELIN	NJ	25088
SIG	SIGNETICS CORPORATION	SUNNYVALE	CA	18324
SIGPT	SIGMA PLASTRONICS	DEARBORN	MI	
SINCR	SINCLAIR & RUSH, INC.	ST. LOUIS	MO	15819
SKDRV	STOCK DRIVE PROD. DIV.	NEW HYDE PARK	NY	
SLCGN	SILICON GENERAL INC	GARDEN GROVE	CA	34333
SLT	SOLITRON/MICROWAVE DIV.	PORT SALERNO	FL	95077
SMTC	SAMTEC INC.	NEW ALBANY	IN	55322
SNSTK	SENSOR TECHNOLOGY CO	SEATTLE	WA	
SOART	STATE OF THE ART, INC	STATE COLLEGE	PA	56235
SOURU	SOURIAU	VAN NUYS	CA	
SOUTH	SOUTHCO FASTENERS	LESTER	PA	94222
SPE	SPECTROL	DAYTON	OH	02111
SPEC	SPECTRUM CONTROL, INC.	FAIRVIEW	PA	33095
SPPRD	SPECIALTY PRODUCTS	INDIANAPOLIS	IN	
SPR	SPRAGUE ELECTRIC CO.	INDIANAPOLIS	IN	56289
SPRTX	SUPERTEX INC.	CUPERTINO	CA	0
SPST	SPECTRA-STRIP	GARDEN GROVE	CA	08261
SPY	SPYRAFLO INC	PEACHTREE CITY	GA	
SSC	SOLID STATE SCIENTIFIC	MONTGOMERYVILLE	PA	31019
STC	SILICON TRANSISTOR CORP	CHELMSFORD	MA	
STDPS	STANDARD PRESSED STEEL	JENKINTOWN	PA	03680
STI	SEMICNDTR TECHNOLOGY INC	STUART	FL	
STKFS	STAKE FASTENERS	SOUTH EL MONTE	CA	
STR	STETTNER TRUSH CO.	CAZENOVIA	NY	52763
STSA	STEEL SALES	INDIANAPOLIS	IN	XXXXX
SULL	SULLINS ELECTRONICS CORP	SAN MARCOS	CA	
SXNBG	SAXONBURG CERAMICS	SAXONBURG	PA	
SYL	GTE SYLVANIA	WALTHAM	MA	94131
SYN	SYNTRONIC INSTRUMENTS	ADDISON	IL	99409
SYNTC	SYNTAC CORP.	CLEVELAND	OH	
SYNTK	SYNERTEK	**	*	

ABBR.	NAME.....	CITY.....	ST	FSCM.
SYS	SYSCON INTERNATIONAL, INC.	SOUTH BEND	IN	32436
T-B	THOMAS & BETTS	RARITAN	NJ	59730
T-I	TEXAS INSTRUMENTS	DALLAS	TX	01295
TAPP	TAPE PRODUCTS, INC	*****	**	
TCPL	TACONIC PLASTIC	PETERSBURG	NY	59688
TEK	TEKTRONIX	INDIANAPOLIS	IN	80009
TEKA	TEKA PRODUCTS INC.	COLLEGE POINT	NY	58050
TEKNT	TECKNIT	CRANFORD	NJ	
TELE	TELETYPE CORP.	ELK GROVE VILLAGE	IL	XXXXX
TELRY	TELEDYNE RELAYS	HAWTHORNE	CA	11532
TFI	T&F INDUSTRIES DIV.	ROLLING MEADOWS	IL	58933
THMST	THERMOSET	INDIANAPOLIS	IN	
THR	THERMALLOY CO.	DALLAS	TX	13103
TIMES	TIMES WIRE AND CABLE	CINCINNAI	OH	XXXXX
TIN	TINNERMAN PRODUCTS, INC.	CLEVELAND	OH	78553
TKN	TECHNICAL WIRE	CRAWFORD	NJ	XXXXX
TLNC	TELONIC ALTAIR	LAGUNA BEACH	CA	04423
TLSBY	TILSBY	*****	**	
TOKO	TOKO AMERICA	SKOKIE	IL	
TORCO	TOR CORP.	VAN NUYS	CA	XXXXX
TR-UT	TRIAD-UTRAD DIV.	HUNTINGTON	IN	0
TRIYX	TRIONYX INDUSTRIES	INDIANAPOLIS	IN	
TRNSN	TRANSENE CO., INC.	ROWLEY	MA	53796
TRU	WALDES TRUARC	LONG ISLAND CITY	NY	79136
TRW	TRW CAPACITOR DIV.	OGALLALA	NB	84411
TSHBA	TOSHIBA AMERICA INC	WAYNE	NJ	00000
TUSNX	TUSONIX, INC.	TUCSON	AZ	59660
TVL	TEL-VISION LABS	WAUCONDA	IL	0
TWAY	TWAY COMPANY	INDIANAPOLIS	IN	0
TYTON	TYTON CORP.	MILWAUKEE	WI	
U-C	UNIVERSAL COMPONENTS	LOS ANGELES	CA	82933
ULSP	UNDERWRITERS LAB. SPEC.	CHICAGO	IL	0
UNCAR	UNION CARBIDE COMPONENTS	GREENVILLE	SC	57185
UNCHM	UNITED CHEMI-CON			
UNIC	UNICORP	ORANGE	NJ	04729
UNIT	UNITRODE CORP.	WATERTOWN	MA	12969
USECO	USECO DIV.	VAN NUYS	CA	88245
USMFS	USM FASTENER DIV.	SHELTON	CT	07707
UTK	UNITRACK DIV.	UPPER DARBY	PA	XXXXX
VAC	VACTEC INC.	MARYLAND HEIGHTS	MO	18178
VACO	VACO PRODUCTS CO.	NORTHBROOK	IL	79061
VAR	VARADYNE CAPACITOR DIV.	SANTA MONICA	CA	26654
VARIL	VARI-L CO.	DENVER	CO	05375
VARO	VARO SEMICONDUCTOR INC	GARLAND	TX	
VCTRN	VECTRON LABORATORIES,INC.	NORWALK	CT	27802
VELCR	VELCRO USA INC	NEW YORK	NY	11153
VIC	VICTOREEN INC	CLEVELAND	OH	
VISCM	VISUAL COMM	PLAYA DEL REY	CA	56769
VLIER	VLIER ENGINEERING CORP.	BURBANK	CA	01226
VLTRX	VOLTREX	*****	**	
VONGT	VONNEGUT HARDWARE	INDIANAPOLIS	IN	XXXXX
VRN	VERNITRON CORP.	GREAT NECK	NY	XXXXX
VSSNC	VIEWSONICS, INC.	SYOSSET	NY	59100

ABBR.	NAME.....	CITY.....	ST	FSCM.
VTRMN	VITRAMON, INC.	BRIDGEPORT	CT	95275
W-E	WELLS ELECTRONICS	SOUTH BEND	IN	14329
W-I	WAVETEK INDIANA, INC.	BEECH GROVE	IN	34280
WAG	WAGNER ELECTRIC CORP.	ST. LOUIS	MO	63477
WBSH	WABASH RELAY & ELECT.	WABASH	IN	18542
WECK	WECKESSER CO., INC.	CHICAGO	IL	95987
WHBRY	W.H.BRADY INDL PRDS DIV	MILWAUKEE	WI	
WHTMN	WHITMAN	CINCINNATI	OH	
WKFLD	WAKEFIELD ENGINEERING	WAKEFIELD	MA	05820
WLDM	WALDOM	CHICAGO	IL	92219
WMBG	W.M. BERG	ROCKAWAY	NY	
WNSL	WEINSCHEL ENGINEERING	GAITHERSBURG	MD	93459
WNZLR	WINZLER MFG	CHICAGO	IL	09109
WRC	WIRE RESEARCH CORP	SANTA ANA	CA	
WRGPA	W. R. GRACE AND CO. POLYFIB RON DIV.	ROANOKE RAPIDS	NC	53718
WSD	WAVETEK	SAN DIEGO	CA	23338
WSTN	WESTON COMPONENTS	ARCHBALD	PA	94075
X-MRO	X-MICRO			
ZEN	ZENITH RADIO CORP.	CHICAGO	IL	67177
ZERO	ZERO MANUFACTURING CO.	BURBANK	CA	98376
ZIE	ZIERICK MFG. CORP.	MOUNT KISCO	NY	79963
ZPT	ZIPPERTUBING, CO.	LOS ANGELES	CA	07240

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
HH01	HARNESS ASSY,A	1219-00-0243	W-I	1219-00-0243	1.000
HH02	HARNESS ASSY,B	1219-00-0368	W-I	1219-00-0368	1.000
HH03	HARNESS ASSY,C	1219-00-0369	W-I	1219-00-0369	1.000
P09	LINE CORD,3-COND,SVT 18 GA,7-1/2 FT,W/REC	17250C	BEL	6011-80-0006	1.000
ZA01	H.V. ASSY	1115-00-0029	W-I	1115-00-0029	1.000
ZA02	PS/Z-AXIS BLNK BD	1110-00-1360	W-I	1110-00-1360	1.000
ZA03	V/H AMP BD	1110-00-1351	W-I	1110-00-1351	1.000
ZA04	PRE-AMP ASSY	1110-00-1420	W-I	1110-00-1420	1.000
ZA05	CHASSIS ASSY	1111-00-0132	W-I	1111-00-0132	1.000

WAVETEK PARTS LIST

TITLE
DISPLAY SCOPE,9 IN

ASSEMBLY NO.
1010-00-0201

PAGE: 1

REV
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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C310 C311 C312 C313	CAP,DISC,6KV,560PF	E62U561M6KV	MDC	1510-10-6561	4.000
CR304 CR305 CR306 CR307	DIODE,RECT,7000V	G7F-7KV-10MA-150NS	GAL	4806-02-0070	4.000
Q302	TRANS QB000-025	MJE803	MOT	4902-00-8030	1.000
Q303	TRANS QB000-023	MJE242	MOT	4902-00-2420	1.000
T301	XFMR,HV,TT002-028	TT002-028	TR-UT	5610-00-0022	1.000
ZA01	HV BD	1218-00-1390	W-I	1218-00-1390	1.000

WAVETEK PARTS LIST

TITLE
H.V. ASSY

ASSEMBLY NO.
1115-00-0029

PAGE: 1

REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C301 C302 C303	CAP,DISC,1KV,.01UF	50A-S10	SPR	1510-10-1103	3.000
C304	CAP,ELEC,50V,10UF	TE1304	SPR	1510-20-5100	1.000
C305	CAP,ELEC,50V,50UF	TE1307	SPR	1510-20-5500	1.000
C306	CAP,MYLR,200V,.22UF	WMF2P22	C-D	1510-60-0224	1.000
C307	CAP,ELEC,25V,100UF	TE1211	SPR	1510-20-4101	1.000
C308	CAP,MYLR,100V,.15UF	WMF1P15	C-D	1510-60-2154	1.000
C309	CAP,MYLR,200V..1UF	WMF2P1	C-D	1510-60-0104	1.000
CR301	DIODE,ZENER,12V	1N4742A	MOT	4801-02-0003	1.000
CR302	DIODE,RECT,400V	1N4004	P-C	4806-01-4004	1.000
CR303	DIODE,RECT,7000V	G7F-7KV-10MA-150NS	GAL	4806-02-0070	1.000
P303	PLUG,RA,7-PIN	09-75-1071	MOL	2112-06-0007	1.000
Q301	TRANS QA053-060	2N5306	G-E	4901-05-3060	1.000
R301	RES,C,1/2W,5%,1.8M	CF1/2-1.8M	ASE	4700-25-1804	1.000
R302	RES,C,1/4W,5%,680K	CF1/4-680K	ASE	4700-15-6803	1.000
R303	POT,50K,RP129-350	360S503B	CTS	4610-00-1503	1.000

WAVETEK PARTS LIST	TITLE HV BD	ASSEMBLY NO. 1218-00-1390 PAGE: 1	REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R304	RES,C,1/4W,5%,91K	CF1/4-91K	ASE	4700-15-9102	1.000
R305	POT., 20%, 1 MEG	360S105B	CTS	4610-00-1105	1.000
R306	RES,C,1/2W,5%,12	CF1/2-12	ASE	4700-25-1209	1.000
R307	RES,C,2W,5%,180	HB1815	A-B	4700-45-1800	1.000
R308	RES,C,1/4W,5%,10K	CF1/4-10K	ASE	4700-15-1002	1.000
R309	RES,C,1/4W,5%,47K	CF1/4-47K	ASE	4700-15-4702	1.000
R310	RES,WW,5W,5%,100	243E1015	SPR	4702-35-1000	1.000
R311	RES,C,1/4W,5%,3.9K	CF1/43.9K	ASE	4700-15-3901	1.000
R312	RES,C,1/4W,5%,220	CF1/4-220	ASE	4700-15-2200	1.000
R313	RES,C,1/2W,5%,1M	CF1/2-1M	ASE	4700-25-1004	1.000

WAVETEK PARTS LIST	TITLE HV BD	ASSEMBLY NO. 1218-00-1390	REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
1	IC SKT,8 PIN	DILB-8P-108	BURND	2112-00-0007	1.000
C101 C102 C108 C109 C114 C115	CAP,DISC,100V,.05UF	TG-S50	SPR	1510-10-2503	6.000
C103	CAP,TANT,25V,1UF	100DE105K25A2	ACI	1510-21-7010	1.000
C104	CAP,DISC,1KV,.01UF	5GA-S10	SPR	1510-10-1103	1.000
C105	CAP,DISC,1KV,100PF	60U101M	MDC	1510-10-1101	1.000
C106 C107	CAP,DISC,1KV,470PF	60U471M	MDC	1510-10-1471	2.000
C110	CAP,ELEC,50V,50UF	TE1307	SPR	1510-20-5500	1.000
C111	CAP,DISC,1KV,68PF	68U2J680J	MDC	1510-10-3680	1.000
C112 C113	CAP,ELEC,25V,100UF	TE1211	SPR	1510-20-4101	2.000
C116 C117 C118 C119	CAP,ELECT,35V,4700UF	503D478F035UK	SPR	1510-23-1472	4.000
C120	CAP,ELEC,100V,25UF	TT100X25	MAL	1510-21-3250	1.000
C121 C122	CAP,ELEC,250V,20UF	WBR20-250	C-D	1510-20-6200	2.000
CR101 CR102 CR103 CR104 CR107 CR110 CR111	DIODE,SIGNAL	1N914	G-E	4807-01-0914	7.000
CR105 CR106 CR108 CR109 CR113 CR118 CR119 CR120	DIODE,RECT,400V	1N4004	P-C	4806-01-4004	8.000

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
CR112	DIODE,ZENER,68V	1N4760	MOT	4801-02-0004	1.000
CR114 CR115 CR116 CR117	DIODE,RECT,200V	1N5624	G-E	4806-01-5624	4.000
IC101	DUAL OP AMP	TL082CP	T-I	7000-00-8200	1.000
IC102	VOLT REG,+15V	UA78M15UC	FCD	7000-78-1500	1.000
IC103	NEG VOLTAGE REG	UA79M15AUC	FCD	7000-79-1500	1.000
P04	CONN,15-PIN,KONEKTON	09-65-1151	MOL	2112-05-0003	1.000
P05	PLUG, 3-CKT	09-65-1031	MOL	2112-05-0008	1.000
Q101 Q106	TRANS QB000-027	MPS-H55	MOT	4902-00-0550	2.000
Q102	TRANS QB000-026	AD3958	A-D	4902-03-9580	1.000
Q103	TRANS QB000-009	MPS3702	NAT	4902-03-7020	1.000
Q105 Q107	TRANS QB000-032	MPS-H05	MOT	4902-00-0050	2.000
R101 R102	RES,C,1/4W,5%,220K	CF1/4220K	ASE	4700-15-2203	2.000
R103 R104	RES,C,1/4W,5%,2.2M	CF1/4-2.2M	ASE	4700-15-2204	2.000
R105 R107 R118 R119	RES,C,1/4W,5%,220	CF1/4-220	ASE	4700-15-2200	4.000
R106	RES,C,1/4W,5%,47K	CF1/4-47K	ASE	4700-15-4702	1.000

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R108 R112	RES,C,1/4W,5%,1.5K	CF1/4-1.5K	ASE	4700-15-1501	2.000
R109 R120	RES,C,1/4W,5%,390	CF1/4-390	ASE	4700-15-3900	2.000
R110 R111 R125	RES,C,1/4W,5%,470	CF1/4-470	ASE	4700-15-4700	3.000
R113 R115	RES,C,1/4W,5%,10K	CF1/4-10K	ASE	4700-15-1002	2.000
R114	POT,10K,RP129-310	360S103B	CTS	4610-00-1103	1.000
R116	RES,C,1/4W,5%,100K	CF1/4-100K	ASE	4700-15-1003	1.000
R117	RES,C,1/4W,5%,2.2K	CF1/4-2.2K	ASE	4700-15-2201	1.000
R121	RES,C,1/4W,5%,1.2K	CF1/4-1.2K	ASE	4700-15-1201	1.000
R122 R123	RES,C,1W,5%,15K	GB1535	A-B	4700-35-1502	2.000
R124 R126	RES,C,1/4W,5%,1K	CF1/4-1K	ASE	4700-15-1001	2.000
R127	RES,C,1/4W,5%,3.9K	CF1/43.9K	ASE	4700-15-3901	1.000
R128	RES,C,1/2W,5%,2.2K	CF1/2-2.2K	ASE	4700-25-2201	1.000
S101	SLIDE SWITCH	GF126	C-W	5105-00-0001	1.000

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
1	IC SKT,8 PIN	DILB-8P-108	BURND	2112-00-0007	2.000
C201 C203	CAP,DISC,100V,.1UF	TGP-10	SPR	1510-10-2104	2.000
C202	CAP,DISC,1KV,15PF	10TCC-Q15	SPR	1510-10-0150	1.000
C204	CAP,DISC,1KV,.01UF	5GA-S10	SPR	1510-10-1103	1.000
CR201 CR202 CR203 CR204 CR205 CR206 CR207 CR208 CR209 CR210 CR211 CR212 CR213 CR214 CR215 CR216 CR217 CR218 CR219 CR220 CR221 CR222 CR223 CR224	DIODE,SIGNAL	1N914	G-E	4807-01-0914	24.000
CR225 CR226	DIODE,RECT,400V	1N4004	P-C	4806-01-4004	2.000
IC201 IC202	DUAL OP AMP	TL082CP	T-I	7000-00-8200	2.000
P01	CONN,15-PIN,KONEKTON	09-65-1151	MOL	2112-05-0003	1.000
P02	CONN,PC MOUNT,5 CKT	09-18-5051	MOL	2112-35-0001	1.000
P06	PLUG,LOCKING	09-65-1121	MOL	2112-05-0004	1.000
Q201 Q204 Q207 Q209	TRANS QA039-050	2N3905	NAT	4901-03-9050	4.000
Q202	TRANS QB000-022	MJE252	MOT	4902-00-2520	1.000
Q203 Q206 Q208 Q210	TRANS QA039-040	2N3904	NAT	4901-03-9040	4.000

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
Q205	TRANS QB000-023	MJE242	MOT	4902-00-2420	1.000
R201 R202	RES,C,1/4W,5%,100K	CF1/4-100K	ASE	4700-15-1003	2.000
R203 R241	RES,C,1/4W,5%,10K	CF1/4-10K	ASE	4700-15-1002	2.000
R204 R208 R210 R215 R216 R227 R229 R235 R236 R242 R245 R246 R259 R260	RES,C,1/4W,5%,1K	CF1/4-1K	ASE	4700-15-1001	14.000
R205 R225 R233 R256	RES,C,1/4W,5%,4.7K	CF1/4-4.7K	ASE	4700-15-4701	4.000
R206 R226 R234 R258	RES,C,1/4W,5%,470	CF1/4-470	ASE	4700-15-4700	4.000
R207 R220 R238 R257	RES,C,1/4W,5%,2K	CF1/4-2K	ASE	4700-15-2001	4.000
R209 R228	RES,C,1/4W,5%,620	CF1/4-620	ASE	4700-15-6200	2.000
R211 R212 R219 R230 R231 R264	RES,WW,5W,5%,1	243E1R05	SPR	4702-35-1008	6.000
R213 R243	RES,VAL DET IN CALIB	RES,TRIM	W-I	4799-99-9999	2.000
R214 R244	RES,C,1/4W,5%,2.7K	CF1/4-2.7K	ASE	4700-15-2701	2.000
R217 R247	RES,C,1/2W,5%,220	CF1/2-220	ASE	4700-25-2200	2.000
R218	RES,WW,10W,5%,50	247E5005	SPR	4702-75-5009	1.000

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R221 R222 R224 R251 R252 R254	RES,C,1/4W,5%,47K	CF1/4-47K	ASE	4700-15-4702	6.000
R223 R253	POT,250K	360T254B	CTS	4610-00-3254	2.000
R232 R255	RES,C,1/4W,5%,27K	CF1/4-27K	ASE	4700-15-2702	2.000
R237 R261	RES,C,1W,5%,3	GB30G5	A-B	4700-35-3008	2.000
R239 R240	RES,C,1/4W,5%,470K	CF1/4-470K	ASE	4700-15-4703	2.000
R248 R262	RES,C,2W,10%,1K	HB1021	A-B	4700-46-1001	2.000
R249	RES,WW,10W,5%,200	247E2015	SPR	4702-75-2000	1.000
R250	RES,WW,3W,5%,5	242E5R05	SPR	4702-55-5008	1.000

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
1	IC SKT,8 PIN	DILB-8P-108	BURND	2112-00-0007	2.000
C601	CAP,FILM,80V,.01UF	192P1039R8	SPR	1510-60-3103	1.000
C602	CAP,MICA,500V,.001UF	DM15-102J	ARC	1510-50-0102	1.000
C603	CAP,DISC,1KV,100PF	10TCU-T10	SPR	1510-10-3101	1.000
C604	CAP,DISC,1KV,10PF	10TCC-Q10	SPR	1510-10-0100	1.000
C605 C609 C610	CAP,DISC,100V,.05UF	TG-S50	SPR	1510-10-2503	3.000
C606	CAP,DISC,1KV,20PF	60C0G200J	MDC	1510-10-0200	1.000
C611 C613	CAP,ELEC,25V,100UF	TE1211	SPR	1510-20-4101	2.000
C612 C614	CAP,ELEC,10V,150UF	503D157F010NB	SPR	1510-20-8151	2.000
CR601 CR602	DIODE,SIGNAL	1N914	G-E	4807-01-0914	2.000
CR603 CR604	DIODE,ZENER,6.2V	1N4735	MOT	4801-01-4735	2.000
IC601 IC602	DUAL OP AMP	TL082CP	T-I	7000-00-8200	2.000
J601	CONN,FEMALE,15-PIN	09-52-3151	MOL	2113-06-0020	1.000
P601	CONN,15-PIN,KONEKTON	09-65-1151	MOL	2112-05-0003	1.000
P602	PLUG,RA,15-PIN	09-75-1151	MOL	2112-06-0005	1.000

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R601	RES,MF,1/8W,1%,1K	RN55D-1K	MILSP	4701-03-1001	1.000
R602	RES,MF,1/8W,1%,9.09K	RN55D-9.09K	MILSP	4701-03-9091	1.000
R603	RES,MF,1/8W,1%,90.9K	RN55D-90.9K	MILSP	4701-03-9092	1.000
R604	RES,MF,1/8W,1%,909K	RN55D-909K	MILSP	4701-03-9093	1.000
R606 R611 R614	RES,C,1/4W,5%,1K	CF1/4-1K	ASE	4700-15-1001	3.000
R607	RES,C,1/4W,5%,10K	CF1/4-10K	ASE	4700-15-1002	1.000
R608 R609 R610	RES,C,1/4W,5%,2K	CF1/4-2K	ASE	4700-15-2001	3.000
R612	RES,MF,1/8W,1%,374K	RN55D-374K	MILSP	4701-03-3743	1.000
R613	POT,CONT,100K	360T104B	CTS	4610-00-3104	1.000
R616	RES,C,1/4W,5%,680	CF1/4-680	ASE	4700-15-6800	1.000
R617	RES,C,1/4W,5%,1M	CF1/4-1M	ASE	4700-15-1004	1.000
R618	POT,250K,RP131-425	360T254B	CTS	4610-00-3254	1.000
R619	RES,C,1/4W,5%,3.9K	CF1/43.9K	ASE	4700-15-3901	1.000

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
1	CONTACT MC000-068	08-50-0107	MOL	2113-07-0001	3.000
2	TERM,FEMALE	02-09-1118	MOL	2113-09-0003	4.000
C01 C02	CAP,MYLR,200V,.22UF	WMF2P22	C-D	1510-60-0224	2.000
CR01	LED,GN,T-1-3/4	HLMP-3507	H-P	4810-02-0003	1.000
F01	FUSE,S.B.,2AMP	MDX-2	BUS	2410-05-0001	1.000
J01 J07 J09	CONN,BNC-F,50,PANEL	31-010	APL	2110-01-1005	3.000
J05	PLUG, 3-CKT	09-65-1031	MOL	2112-05-0008	1.000
L01	YOKE,PER:B/P	1812-00-0003	W-I	1812-00-0003	1.000
NONE_	DECAL,SER.NO.	DMB-11	W-I	2410-04-0001	1.000
P08	FUSEHLDR/LINE RECEPT	6J1	CCM	2410-05-0017	1.000
Q01	TRANS QB000-030	TIP36C	T-I	4902-00-0360	1.000
Q02	TRANS QB000-029	TIP35C	T-I	4902-00-0350	1.000
Q03	TRANS QB000-024	MJE703	MOT	4902-00-7030	1.000
Q04	TRANS QB000-025	MJE803	MOT	4902-00-8030	1.000
R01 R02 R04 R05	POT,10K	WA2G032S103MA	A-B	4610-10-7103	4.000

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R03	POT,1M	WA2G032S-105MA	A-B	4610-10-7105	1.000
R06	POT,20K	WA2G032S-203MA	A-B	4610-10-7203	1.000
R07	RES,C,1/4W,5%,390	CF1/4-390	ASE	4700-15-3900	1.000
R08	RES,C,1/2W,5%,820	CF1/2-820	ASE	4700-25-8200	1.000
S01	SWITCH,ASSY,ROTARY	399646-512	OAK	5104-00-0008	1.000
S03 S04 S05 S06	SLIDE SWITCH	GF126	C-W	5105-00-0001	4.000
S07	SWITCH,TOGGLE DPDT	9201P3HZQ	C-K	5106-00-0016	1.000
T01	XFMR,PWR,48VCT,1.6A	5610-00-0037	W-I	5610-00-0037	1.000
V01	CRT,9IN,P1 PHOS	CE399M9P1GE	C-E	5710-00-0013	1.000

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
1	CRT SKT,MC000-061	JCK2300	IEH	2112-00-0014	1.000
2	CONTACT MC000-068	08-50-0107	MOL	2113-07-0001	13.000
3	CONTACT,MC000-131	08-50-0106	MOL	2113-07-0002	22.000
J03	7-PIN JACK	09-50-3071	MOL	2113-06-0007	1.000
J04 J11	CONN,15-PIN,KONEKTON	09-50-3151	MOL	2113-06-0003	2.000

WAVETEK PARTS LIST

TITLE
HARNESS ASSY,A

ASSEMBLY NO.
1219-00-0243

PAGE: 1

REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
1	CONTACT MC000-068	08-50-0107	MOL	2113-07-0001	15.000
P10	CONN,15-PIN,KONEKTON	09-50-3151	MOL	2113-06-0003	1.000

WAVETEK PARTS LIST

TITLE
HARNESS ASSY,B

ASSEMBLY NO.
1219-00-0368

PAGE: 1

REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
1	CONTACT MC000-068	08-50-0107	MOL	2113-07-0001	12.000
J06	CONN,12-CIRCUIT	09-50-3121	MOL	2113-06-0005	1.000

WAVETEK PARTS LIST

TITLE
HARNESS ASSY,C

ASSEMBLY NO.
1219-00-0369

PAGE: 1

REV

SECTION 6
SCHEMATICS

6.1 INTRODUCTION

This section contains all schematics for the instrument.

6.2 SCHEMATIC NOTES

The following notes and abbreviations pertain to all schematics. Additional notes pertaining to specific schematics are included on each schematic if required.

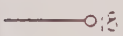
Unless otherwise noted, resistor values are given in ohms, capacitor values are given in pF, and inductor values are given in μH.

SYMBOL NOTES

Denotes DC voltage reading unless otherwise specified.

Denotes high-impedance crystal detector reading in volts unless otherwise specified.

Denotes 50 ohm crystal detector reading in volts unless otherwise specified.



Signal or voltage source.

Connects to indicated signal or voltage source.

Arrow indicates clockwise rotation of wiper.

Coaxial jack

Coaxial plug

Coaxial cable

Factory adjusted part.

Denotes a front-panel device.

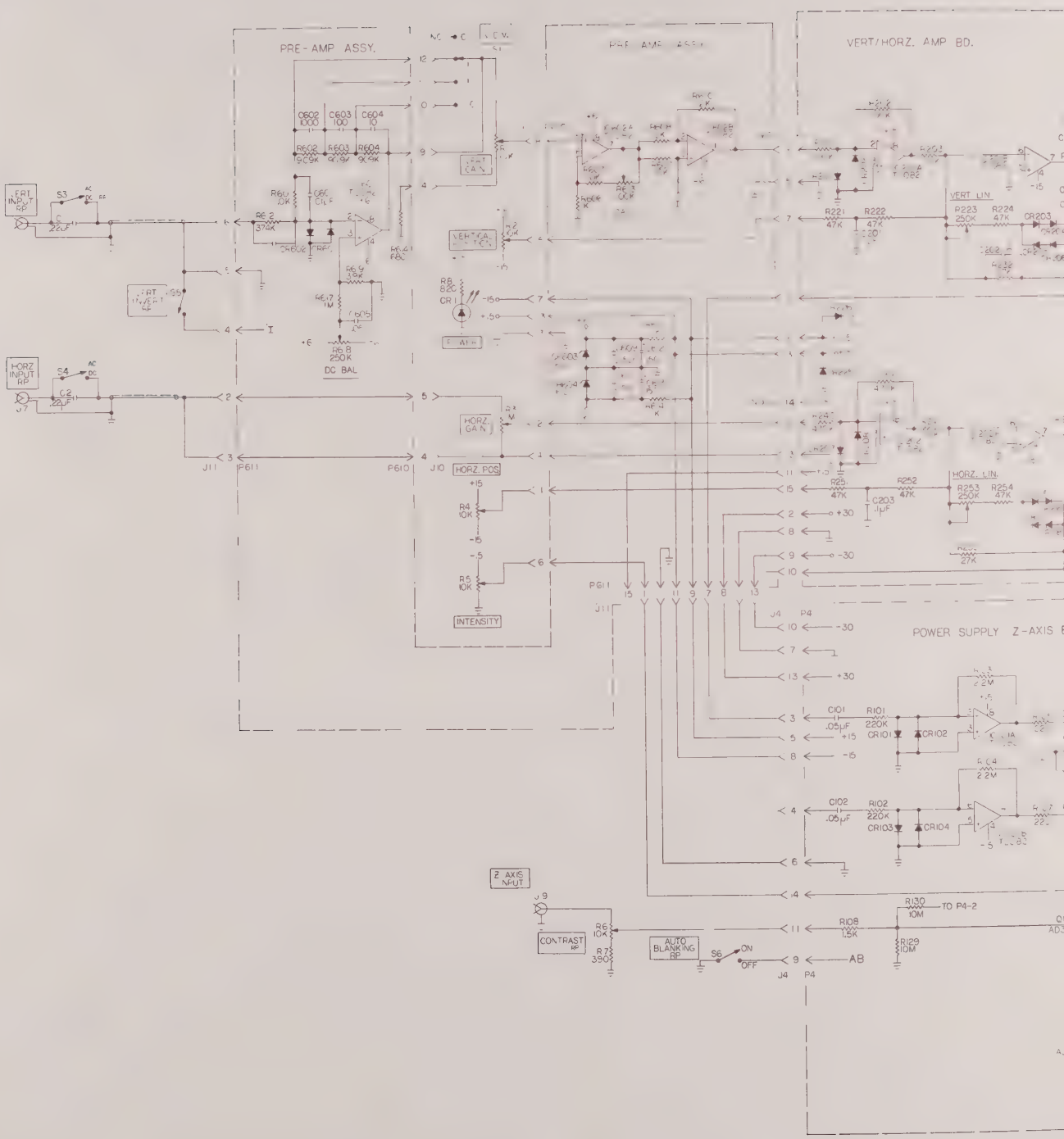
Denotes a rear-panel device.

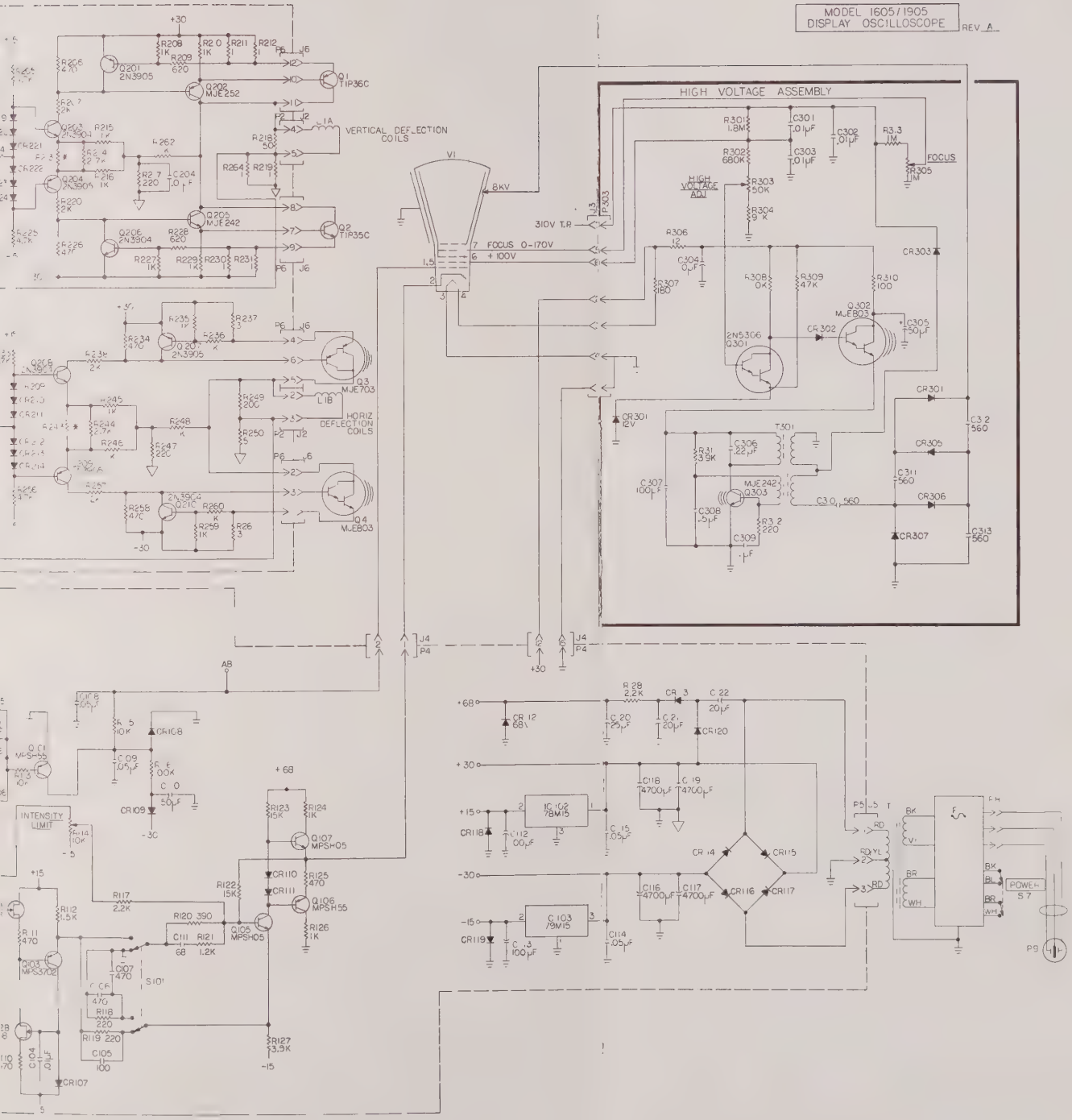
Denotes a printed circuit board adjustment or accessible module adjustment.

Denotes an internal module adjustment not accessible without removing module cover.

ABBREVIATION CODE

A	ampere	IF	intermediate frequency	Ω	ohm
AC	alternating current	J	jack	OC	opto-coupler
C	capacitor	K	relay	P	plug
ccw	counterclockwise	kHz	kilohertz	p	peak
CR	diode	kΩ	kilohm	pp	peak-to-peak
CW	continuous wave	kV	kilovolt	pF	picofarad
cw	clockwise	kW	kilowatt	Q	transistor
dB	decibel	L	inductor	R	resistor
dBc	dB referred to carrier	M	meter	RF	radio frequency
dBm	dB referred to 1 mW	MHz	megahertz	RMS	root-mean-square
dBmV	dB referred to 1 mV	MΩ	megohm	R.P.	rear panel
DC	direct current	mA	milliampere	S	switch
DS	indicating device, lamp	mH	millihenry	T	transformer
F	farad	mV	millivolt	T.P.	test point
F.P.	front panel	mW	milliwatt	V	volt
H	henry	μF	microfarad	VA	voltampere
Hz	hertz	μA	microampere	W	watt
IC	integrated circuit	μH	microhenry	X	crystal


PRE-AMP ASSY.
VERT/HORZ. AMP BD.
VERT INPUT RP
HORZ INPUT RP
DC BAL
HORZ. GAIN
HORZ. POS.
INTENSITY
VERT. GAIN
VERT. LIN.
HORZ. LIN.
POWER SUPPLY Z-AXIS
Z AXIS INPUT
CONTRAST RP
AUTO BLANKING RP
TO P4-2
J11
P611
P610
J10
P611
J4
P4


MODEL 1605/1905
DISPLAY OSCILLOSCOPE
REV A
HIGH VOLTAGE ASSEMBLY
VERTICAL DEFLECTION COILS
HORIZ DEFLECTION COILS
8KV
310V T.R
FOCUS 0-170V
+100V
FOCUS
HIGH VOLTAGE ADJ
INTENSITY LIMIT
POWER
S7
+30
-30
+15
-15
+68
Q1 TIP36C
Q2 TIP35C
Q3 MJE703
Q4 MJE803
Q201 2N3905
Q202 MJE252
Q203 2N3904
Q204 2N3905
Q205 MJE242
Q206 2N3904
Q207 2N3905
Q208 2N3904
Q209 2N3905
Q301 2N5306
Q302 MJE803
Q303 MJE242
Q101 MPSH55
Q102 MPSH05
Q103 MPSH02
Q104 MPSH05
Q105 MPSH05
Q106 MPSH55
Q107 MPSH05
IC 102 78M15
IC 103 79M15
T301
CR301
CR302
CR303
CR306
CR307
CR108
CR109
CR110
CR111
CR115
CR116
CR117
CR118
CR119
CR120
J4 P4
J6 P6
J2 P2
P5
P9
L1A
L1B
S101

MP MASTER
MA33505